İSTANBUL TECHNICAL UNIVERSITY ★ INSTITUTE OF SCIENCE AND TECHNOLOGY

SERVICE VALUE CREATION IN SUPPLIER-BUYER INTERACTIONS: AN EXPERT SYSTEM APPROACH

Ph.D. Thesis by

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TEDARİKÇİ-ALICI ETKİLEŞİMLERİNDE HİZMETİN DEĞER YARATIMI: BİR UZMAN SİSTEM YAKLAŞIMI

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December 2007 **Didem Selcen ÖZTÜRKCAN AYKAÇ**

TABLE OF CONTENTS

Page No

ABBREVIATIONS

SCM	: Supply Chain Management
ICT	: Information and Communication Technologies
Q	: Question
SQ	: Service Quality Dimension
S	: Perceived Buyer Value Dimension
GDP	: Gross Domestic Product
ESSER	: Expert System Application for Suppliers to Create Service Value
AI	: Artificial Intelligence
ES	: Expert System
POM	: Production and Operations Management

LIST OF TABLES

Page No

LIST OF FIGURES

LIST OF SYMBOLS

η : Index of refraction
c : Speed of light in vacuum
m : Medium type
v_m : Speed of light in medium m
λ : Wavelength in vacuum
λ_m : Wavelength in the medium m
f : Frequency
θ_i : The angle between light beam and the normal to the surface between mediums

SERVICE VALUE CREATION IN SUPPLIER-BUYER INTERACTIONS: AN EXPERT SYSTEM APPROACH

SUMMARY

Supply chain management has attracted attention from various multi-disciplinary fields, which include manufacturing, operations management, customer management and transportation. Global sourcing, time and quality based competition, improvements in technology, and environmental uncertainties have placed supply chain management as a timely topic for academic research. Defect-free, fast and reliable delivery has almost become the necessities to be in the market, rather than competitive advantage. Ever stiff competition in the global arena calls for closer coordination and better alignment between supply chain participants. Therefore, a closer examination of supplier and buyer interactions is vital. As price becomes the most important feature of a product and reduces profitability and competitive advantage, and as information technology tools that help in a closer coordination with buyer and supplier emerges, suppliers get engaged in providing services around their products. Moreover, service quality is referred as a more important order winner than the product quality. Yet differentiation via services dimension is not an easy concept to grasp. Firms often perform services according to the norms they have established over years of experience. Though, the breadth of experience commonly varies from one firm to another. Therefore, norms adopted for services vary, too. A norm considered for a specific service in one company might not exist at another company, or even if exist could be underestimated. When placed in the context of complex supply chains, this presents a supplier with often buyers that have different services' norms. A certain aspect of a supplier's service might be deemed superior at one buyer, while normal or even inferior at another buyer. Therefore, provision of services in supply chain management presents a promising research area. There is a need to understand if supplier's provision of services is capable of generating superior or inferior perceived buyer value. Suppliers demand more information on sophisticated norms and specifications of their buyers to formulate their services. This research attempts to shed the light on the issues discussed, and also uncover the possible causes of superior perceived buyer value creation upon supplier's provision of services in supply chain. An exploratory research model has been developed by the aid of an analogy from Snell's Law of the physics. A panel of experts had been devised to confirm usefulness and meaningfulness of the developed model. Lastly, attention have been devoted to investigate what should a supplier provide in terms of services in order to create a superior perceived buyer value. It was found that the use of an expert system would allow the elusive and abstract concept of services to be handled in terms of symbolic reasoning. An expert system, ESSER (Expert System Application for Suppliers to Create Service Value), has been developed and tested in collaboration with a Turkish automotive firm's spare parts and logistic department

and her thirty-nine main national buyers. Knowledge acquisition took eight months with six human experts, where direct, indirect and group knowledge acquisition methods had been employed.

The main contributions of this research endeavor are in two folds. First contribution of this research endeavor to academia is the developed exploratory model, which explains creation of superior perceived buyer value via provision of services in a supplier-buyer interaction. Later, an **E**xpert **S**ystem Application for Suppliers to **C**reate **Ser**vice Value (ESSER) is developed based on this model. Therefore, reference disciplines, including supply chain management, services, and expert systems have received contribution. Secondly, an expert system has been developed to assist suppliers in practicing better provision of services. High levels of services are often costly for suppliers to adopt for the entire buyer base due to two major reasons: the unnecessary high costs incurred for buyers who were not necessarily expecting such high services for value creation, and the dramatically raised expectations which will set the base for all forthcoming services of the supplier that'll force the supplier to perform an ever higher levels of services. ESSER not only facilitates detection of possible opportunities to improve service levels through which a supplier can create superior perceived buyer value, but also provides suggestions to ensure such. Lastly, development and testing of ESSER have been accomplished in real industrial setting. The privilege to bring theory and practice together has been a fundamental contribution to the reference fields.

The thesis includes seven sequential chapters. First chapter, *Introduction and Research Question,* provides a general background of the topic along with justification for the need of this research endeavor, problem statement with specific research questions, and both theoretical and practical contributions. Second chapter, *Supply Chain Management,* covers relevant literature across supply chain management, services, and value fields to integrate and explain the creation of superior perceived buyer value in a supplier-buyer interaction upon supplier's provision of services. Third chapter, *Service Value Creation in Supplier-Buyer Interactions: Mirroring Snell's Law,* provides background for Snell's Law and presents the analogy to supplier and buyer interaction. An exploratory model is built then from this analogy. Finally, model usefulness and meaningfulness is sought by the panel of experts devised. Fourth chapter, *Expert Systems,* provides history and theory of expert systems, and discusses application areas, and benefits of expert systems. A comprehensive expert system development process is also outlined. Fifth chapter, *An Expert System Approach for Service Value Creation in Supplier-Buyer Interactions,* provides the undertaken expert system development phases of ESSER (**E**xpert **S**ystem Application for Suppliers to Create **Ser**vice Value). Sixth chapter, *An Application in Automotive Industry,* provides background information on automotive industry, Turkish automotive industry, and application site and reports basic findings on 39 cases in general, and in detail, on one case. Final seventh chapter, *Conclusion and Future Research,* discusses the findings, limitations, implications, and future work that extend the present research endeavor. The dissertation also consists of several appendices, which contain the logic blocks of ESSER.

TEDARİKÇİ-ALICI ETKİLEŞİMLERİNDE HİZMETİN DEĞER YARATIMI: BİR UZMAN SİSTEM YAKLAŞIMI

ÖZET

Tedarik Zinciri Yönetimi (TZY), imalat, yöneylem, müşteri yönetimi ve dağıtım gibi değişik disiplinlerin ilgisini çekmiştir. Küresel tedarik, zaman ve kalite temelli rekabet, teknolojik gelişmeler ve çevresel belirsizlik unsurları sonucunda, TZY akademik araştırmalar için güncel bir başlık haline gelmiştir. Rekabet avantajı olarak görülen hatasız, hızlı ve güvenilir teslimat pazarda yer almanın gereği haline dönüşmüştür. Artan küresel rekabet, tedarik zinciri halkalarının birbirleri ile daha yakın koordinasyon sağlamasını ve kendilerini diğer halkaların konumlarını dikkate alarak daha iyi hizalamalarını gerektirmektedir. Bu sebeple, tedarikçi-alıcı çiftlerinin yakından incelenmesi hayati önem taşımaktadır. Fiyat bir ürünün en önemli özelliği haline dönüştükçe karlılık düşmekte, rekabet avantajı azalmaktadır, buna ek olarak bilişim teknolojilerinin tedarikçi-alıcı çiftlerinin daha yakın koordinasyonuna imkan tanımayan araçları geliştikçe, tedarikçiler ürünlerini sundukları hizmetler ile desteklemektedirler. Öyle ki, hizmet kalitesi, ürün kalitesinden daha önemli bir sipariş kazandıran olarak anılmaktadır. Ancak, hizmetler yolu ile farklılaştırma yakalanması zor bir kavramdır. Firmalar, hizmetlerini yıllar içerisinde kazandıkarı deneyimler sonucu belirledikleri normlara göre yapılandırırlar. Ancak, bu deneyimlerin kapsamı firmadan firmaya değişiklik göstermektedir. Bu değişiklik, hizmetler için uyarlanan normlarda da değişikliğe yol açmaktadır. Bir firmanın, belirli bir hizmet için dikkate aldığı bir norm, bir başka firmada daha az önem arz edilebilmekte yada hiç dikkate alınmayabilmektedir. Tedarik zincirinin karmaşık yapısı içerisinde bu değişkenlik, tedarikçinin birbirinden farklı hizmet normları olan alıcıları oluşmasına sebep olmaktadır. Tedarikçinin hizmetinin belli bir unsuru bir alıcı da üstün olarak değerlendirilirken, başka bir alıcı tarafından sıradan veya vasat olarak değerlendirilebilinmektedir. Tüm bu gelişmeler ışığında, tedarik zinciri yönetimi kapsamında hizmetlerin ele alınması gelecek vaad eden bir araştırma alanı sunmaktadır. Tedarikçinin hizmetlerinin üstün veya vasat alıcı katma değeri yaratması mümkün ise, bu konunun anlaşılmasına ihtiyaç vardır. Tedarikçiler hizmetlerini yapılandırabilmek için alıcılarının beklentilerine ve dikkate aldıkları normlara dair daha fazla bilgiye ihtiyaç duymaktadır. Bu araştırma, tartışılan bu konulara ışık tutmayı ve tedarikçinin hizmetlerinin üstün nitelikli alıcı değeri yaratmasının ardındaki muhtemel sebepleri bulmayı amaçlamaktadır. Bu kapsamda, fizik alanında geliştirilen Snell Kanun'a benzeşme ile keşifsel araştırma modeli geliştirilmiştir. Uzmanlar kurulu ile geliştirilen modelin anlamlılığı ve işe yararlılığı sınanmıştır. Son olarak, tedarikçinin üstün nitelikli alıcı katma değeri yaratabilmesi için hizmetleri kapsamında ele alması gerekenler araştırılmıştır. Sembolik sebeplendirmeye imkan veren uzman sistem yaklaşımının hizmetlerin soyut ve kavranması güç özellikleri sebebi ile uygun olduğu tespit edilmiştir. Geliştirilen

uzman sistem ESSER (**E**xpert **S**ystem Application for Suppliers to Create **Ser**vice Value) adı ile anılmaktadır. Türk otomotiv sektörü liderlerinden bir firmanın yedek parka ve lojistik bölümü ile firmanın 39 ana bayiisinin katılımı ile geliştirilen sistem için bilgi edinimi sürecinden altı uzmandan sekiz ay boyunca faydalanılmıştır. Kullanılan yöntemler direkt, indirekt ve grup bilgi edinimlerini içermiştir.

Bu araştırmanın katkılarını iki başlık altında incelemek mümkündür. İlk olarak, geliştirilen keşifsel model ile tedarikçi-alıcı etkileşimlerinde tedarikçinin ifa ettiği hizmetlerin alıcıda değer yaratımı sürecine ışık tutulmuştur. Ayrıca, bu modele dayanarak ESSER geliştirilmiştir. Bu kapsamda, referans disiplinler olan tedarik zinciri yönetimi, hizmetler ve uzman sistemler literatürlerine katkı yapılmıştır. İkinci olarak, geliştirilen uzman sistem tedarikçilere hizmetlerini alıcıları için katma değer yaratabilecek şekilde iyileştirmeleri için yardımcı olmaktadır. Yüksek hizmet seviyesini tüm alıcıları için uygulamaya koymak tedarikçiler için iki sebeple yüksek maliyetler içermektedir: bu derece yüksek hizmet beklentisi olmayan alıcılar sebebi ile oluşan maliyetler, ve her yüksek hizmet seviyesi sunumunda alıcıların bir daha ki hizmetler için yükselen hizmet seviyesi beklentileri ile tedarikçiyi daha yüksek seviyeli hizmetelere zorlaması. ESSER sadece hizmet kapsamlı iyileştirme fırsatlarını bulgulamakla kalmayıp, tedarikçilere alıcılarının her birinde üstün nitelikli katma değer yaratabilecek hizmetler şekillendirmesi için tavsiyelerde bulunmaktadır. Son olarak, ESSER'i geliştirme ve sınama süreci endüstriden bir firmanın katılımı ile gerçekleştirilmiş, böylece teori ile pratiği bir araya getirebilmek ve referans alanlara katkı yapabilmek mümkün olmuştur.

Doktora tezi yedi ana bölümden oluşmaktadır. İlk bölüm, *Giriş ve Araştırma Sorusu*, konu hakkında genel bir kapsamı, araştırmanın sebeplerini, araştırma sorularını ve hem teorik hem pratik katkıları içermektedir. İkinci bölüm, *Tedarik Zinciri Yönetimi*, tedarik zinciri yönetimi, hizmetler, değer yaratımı alanlarında literature tartışarak, bütünleşik bir yaklaşımlar tedarikçi-alıcı etkileşimlerinde tedarikçinin ifa ettiği hizmetlerin alıcıda değer yaratımı sürecini ortaya koymaktadır. Üçüncü bölüm, *Hizmetlerin Tedarikçi-Alıcı Etkileşimlerinde Değer Yaratımı: Snell Kanunu'ndan bir Uyarlama,* Snell Kanunu ile ilgili bilgi vererek tedarikçi ve alıcı etkileşimine dair benzeşim sunmaktadır. Burada oluşturulan model, anlamlılığı ve kullanılabilirliği başta olmak üzere uzmanlar kurulu yolu ile sınanmıştır. Dördüncü bölüm, *Uzman Sistemler*, tarihi, teorisi, uygulama alanlari, avantaj ve dezavantajlari açısından uzman sistemleri tartışıp, bir uzman sistem geliştirme sürecini detayları ile ele almıştır. Beşinci bölüm, *Tedarikçi-Alıcı Etkileşimlerinde Hizmetlerin Değer Yaratımı için Uzman Sistem Yaklaşımı*, ESSER (Expert System Application for Suppliers to Create Service Value) geliştirme sürecini safhaları ile almaktadır. Altıncı bölüm, *Otomotiv Sektöründe Bir Uygulama*, otomotiv sektörü, Türkiye'deki otomotiv sektörü ve uygulamanın yapıldığı firma hakkında genel bilgiler içermekte, 39 alıcı ile tedarikçinin etkileşimine dair bulguları raporlamakta, bunlardan bir vakayı ise detayları ile almaktadır. Son olarak yedinci bölüm, *Sonuç ve İleri Araştırmalar*, araştırmanın bulgularını, kısıtlarını, katkılarını tartışarak, olası ileri araştırmaları ortaya koymuştur. Ayrıca, tez ESSER'in kurallarını içeren ek bölümler içermektedir.

1. INTRODUCTION AND RESEARCH QUESTION

This chapter provides an introduction of the thesis by broadly explaining the phenomenon under study – service value creation in supplier-buyer interactions: an expert system approach. In the first section, a general background of the topic is provided along with justification for the need of this research endeavor and grand the research question driving it. The following section covers the importance of this research both from a theoretical and practical standpoint. Finally, the general outline of the thesis is presented.

1.1 Problem Statement

"Management is on the verge of a major breakthrough in understanding how industrial company success depends on the interactions between the flows of information, materials, money, manpower, and capital equipment. The way these five flow systems interlock to amplify one another and to cause change and fluctuation will form the basis for anticipating the effects of decisions, policies, organizational forms, and investment choices." (Forrester, 1958)

Via above definition, theory of distribution management that considers the integrated nature of organizational relationships was introduced by Forrester (1958). He discussed that the intertwined structures of organizations affect the influence of system dynamics on research, engineering, sales and promotion performances.

In his attempt to forecast the future, Forrester (1958) contends that subsequent to a period of research and development involving basic analytic techniques, "there will come general recognition of the advantage enjoyed by the pioneering management who have been the first to improve their understanding of the interrelationships between separate company functions and between the company and its markets, its industry, and the national economy." It appears that Forrester identified key management issues and illustrated the dynamics of factors associated with the

phenomenon referred to in contemporary business literature as Supply Chain Management (SCM), though his article is more than forty years old (Mentzer et al., 2001).

Over the past decades, SCM has gained more importance (Cooper et al., 1997) and became a "hot topic" that is frequently researched by often multi-disciplinary approaches of manufacturing, operations management, customer management and transportation (Ross, 1998). Among the many reasons of this popularity, certain drivers can be traced to trends in global sourcing, an emphasis on time and quality-based competition, and their respective contributions to greater environmental uncertainty. Competitive pressures surfacing from worldwide markets have advanced supply chain management (SCM) as a corporate strategy and a timely topic for academic research (Burgess et al., 2006; Ramcharran, 2001; Storey et al., 2006). In addition to novel requirements in businesses, increasing globalization, diminishing international trade restrictions, changing environmental conditions, and state-of-the-art technologies contribute to the crucial role of SCM (Gunasekaran et al., 2004). As companies become increasingly global, they are forced to search for ever effective methods of coordinating the flow of materials, information and finances into and out of the company. As a key to improved coordination, orientation toward closer relationships between buyers and suppliers becomes prominently important. Moreover, companies and the supply chains they are involved with compete often on the basis of time and quality. "Getting a defect-free product to the customer faster and more reliably than the competition is no longer seen as a competitive advantage, but simply a requirement to be in the market. Customers are demanding products consistently delivered faster, exactly on time, and with no damage" (Mentzer et al., 2001). Taken all together, these necessities demand closer coordination and better alignment between supply chain participants, hence, better understanding of supplier-buyer interactions. Indeed many suppliers are adding services around their products, due in part to: *"(1) the commodization of products, where only the price matters and other features are identical, reducing profitability and competitive advantage from the sale of products alone; (2) the need to get closer to the buyer; (3) the increase in information technology capabilities that make such offering possible"*(Simchi-Levi, 2003).

Contemporary industrial practices and SCM definitions suggest that role of services gets emphasized as an important factor for supply chain members to differentiate themselves and gain a further competitive edge. Furthermore, Ghobadian et al. (1994) state that "service quality" is considered a more important order winner than "product quality" in some manufacturing industries. Though, differentiation via services dimension is not an easy concept to grasp. Most services are performed according to norms established by over years of experience. However, the breadth of experiences varies across firms, which in turn, generate various adopted norms for services in different firms. What one firm considers as a norm for a specific service, could easily be underestimated or even do not appear at all among the norms of another firm when the subject under consideration is services. In an effort to align with a supply chain, companies tend to also carry with them a vastly differing array of norms for what they practice as services. As each company develops new norms of services over years of experience, they also re-evaluate their expectations for services they receive from their suppliers. A buyer firm might perceive a certain aspect of a supplier's service superior, while another might deem it normal or even inferior. While breakdown for factors of all sorts of costs are available, the sketchy examination of services presents an untouched problem area. Mathematical approaches that claim supremacy due to involvement of service factors often define complex service-levels only in relation with stock outs (Graves et al., 1998; Lee and Billington, 1993; Minner, 2003; Newhart et al., 1993; Pyke and Cohen, 1994; Talluri and Baker, 2002) Suppliers demand more information on sophisticated specifications to formulate their service inline with the buyer's expectations.

The posed Research Questions in this research are "*Does supplier's provision of services generate superior or inferior perceived buyer value?",* if so "*Why does provision of services within a supply chain create superior perceived buyer value?",* and lastly linked with these, "*What should a supplier provide in terms of services in order to create a superior perceived buyer value?"*

In this context, this research endeavor investigates the first research question in the *Supply Chain Management* chapter, where a review of prior literature which is relevant to the study of superior and inferior perceived buyer value creation in supplier-buyer interaction via supplier's provision of accompanying services is

provided. Since problem domain has received interest from various researchers from different fields of research, an extensive literature base is presented to provide a richer foundation for understanding supply chain management, supplier and buyer interactions, role of services, as well as quality of services.

Second research question is investigated in the *Service Value Creation in Supplier-Buyer Interactions: Mirroring Snell's Law* chapter. The field of Management Science has up to today enjoyed numerous satisfactory theory applications from natural sciences. Among these, simulated annealing is a memoryless emerging optimization technique driven from the heat treatment process of annealing. By building an analogy between the heating and cooling speed as well the energy transferred in these process and complex optimization problems, a successful application is achieved (Onwubolu, 2002). Taking a similar approach, but being the first in the field to mirror Snell's Law, this research builds an analogy between the instantaneous voyage of light beam from one medium to another and the instantaneous provision of services from supplier to buyer in a hybrid good context. In this chapter, the contextual dynamic and assumed relations are modeled by the aid of Snell's Law from the field of Physics in this research, while dimension of services and operationalization of conceptualizations draw upon services and decision support systems literatures, respectively. A panel of experts had been devised to confirm usefulness of the model.

Lastly, attention is devoted to the third research question in the *Expert Systems* chapter, where following three consecutive chapters also serve the quest. Drawing from different areas of research, such as supply chain management, services, value, Snell's Law and decision support science, an expert system is developed, to provide an initial foothold for investigating the phenomenon. The use of expert system allowed the elusive and abstract concept of services to be handled in terms of symbolic reasoning. Knowledge acquisition took eight months with six human experts, where direct, indirect and group knowledge acquisition methods had been employed. The expert system built, ESSER (**E**xpert **S**ystem Application for Suppliers to Create **Ser**vice Value), had been developed and tested by the data retained from a Turkish automotive firm's spare parts and logistics department (supplier) and her thirty nine main national buyers.

In the remainder of this chapter, the implications of this research to both research and practice are presented, followed by a presentation of a general layout of the thesis.

1.2 Implications to Research and Practice

When undertaking a research project, the aim of any researcher should be to conduct research that is both rigorous and relevant. Rigor refers to the ability to draw valid conclusions about evidence and inference based on the research (Straub, 1989), whereas relevance refers to the issues that are interesting and important to practitioners. Thus, this thesis makes an attempt to ensure both rigor and relevance in an attempt to make significant contributions to academia and practice. In the following subsections, the theoretical and practical implications of this study are discussed.

Theoretical Implications

The prevalence of services in supply chains as part of a hybrid good context has piqued the interest of several researchers recently (M.I.T., 2007). While studies have provided an initial foothold in the understanding of services involved in supplier-buyer interactions (Duke, 1998; Li-Ling, 2005; Roy et al., 2004), a common theme emerging from these different studies is a need to further understand the anatomy of buyer value creation via instantaneous provision of accompanying services. The foremost contribution of this research endeavor to academia involves a theoretically grounded explanatory model to explain creation of superior perceived buyer value via provision of services in a supplier-buyer interaction. Based on this model, an **E**xpert **S**ystem Application for Suppliers to Create **Ser**vice Value (ESSER) is developed. This research endeavor has contributed to the literature also by the developed expert system. Consequently, this research endeavor makes significant contribution to the chosen reference disciplines, which include supply chain management, services, and decision support systems.

Practical Implications

An integral part of this research was to provide a decision support system to assist suppliers. The knowledge generated as a result of this research endeavor can also be utilized to better practice. The most obvious contribution of this study is to suppliers. Performing higher levels of services always comes with a cost. A supplier who wishes to create buyer value would have been expected to raise the bar for its provision to its entire buyer base. However, this brings about two major problems: the unnecessary high costs incurred for buyers who were not necessarily expecting such high services for value creation, and the dramatically raised expectations which will set the base for all forthcoming services of the supplier that'll force the supplier to perform an ever higher levels of services. Developed explanatory model's and expert system's use would bestow a supplier the possibility to operationalize an alternating level of service provision across its buyer base that would meet the actual expectations of each of its individual buyers. The developed Expert System not only facilitates detection of possible opportunities where a supplier can create superior perceived buyer value, but also provides suggestions to ensure such.

In addition, the application phase of the expert system took place in the Spare Parts and Logistics Department of a leading Turkish automotive company. This opportunity tackled at a real industrial setting also adds value to this research endeavor.

1.3 Structure of Thesis

The thesis includes seven sequential chapters that are labeled *Introduction and Research Question, Supply Chain Management, Service Value Creation in Supplier-Buyer Interactions: Mirroring Snell's Law, Expert Systems, An Expert System Approach for Service Value Creation in Supplier-Buyer Interactions, An Application in Automotive Industry* and *Conclusion and Future Research* (Figure 1.3.1). The thesis also consists of several appendices, which contain the logic blocks and screen shots of ESSER.

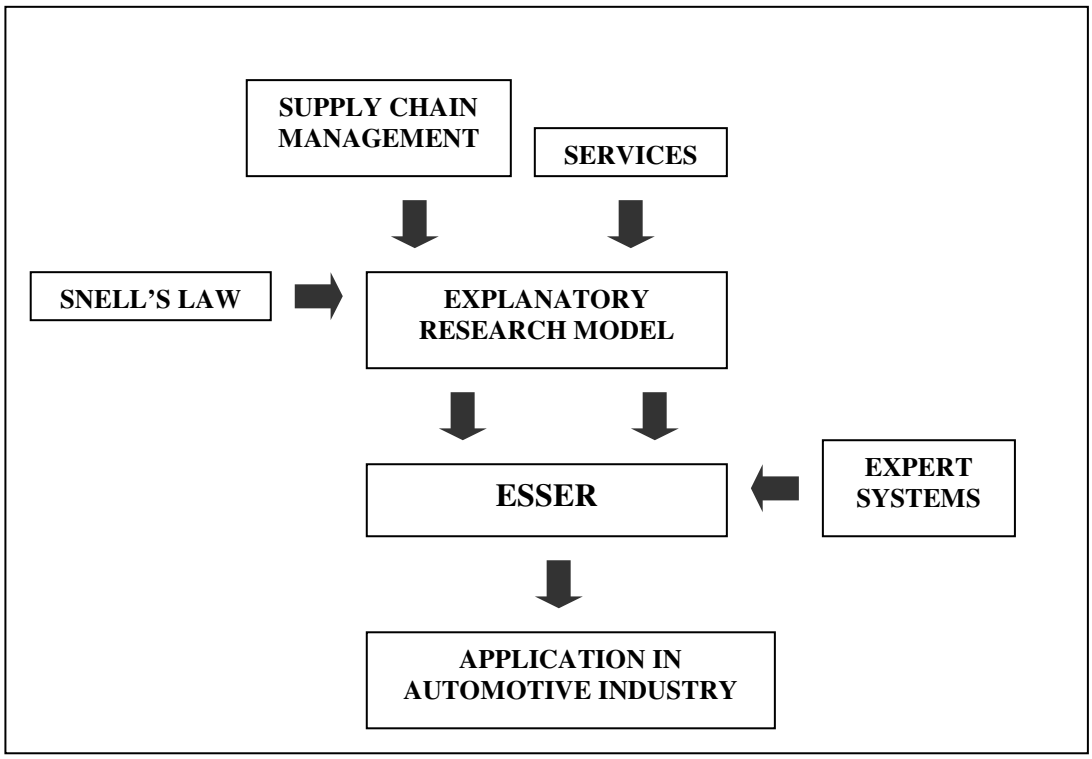

Figure 1.3.1. Thesis overview

The *Introduction and Research Question* chapter provides an introduction of the thesis by broadly explaining the phenomenon under study. A general background of the topic is provided along with justification for the need of this research endeavor and specific research questions. The importance of this research both from a theoretical and practical standpoint is also provided.

The *Supply Chain Management* chapter aims at the first research question, that is "*Does supplier's provision of services generate superior or inferior perceived buyer value?",* therefore it covers the relevant literature across supply chain management, services, and value fields. The reviewed literature is integrated to explain the creation of superior perceived buyer value in a supplier-buyer interaction upon supplier's provision of services.

The *Service Value Creation in Supplier-Buyer Interactions: Mirroring Snell's Law* chapter aims at the second research question, which is "*Why does provision of services within a supply chain create superior perceived buyer value?"* It provides background for Snell's Law and presents the analogy to supplier and buyer

interaction. An exploratory model is built then from this analogy. Finally, model usefulness and meaningfulness is sought by the panel of experts devised.

The *Expert Systems* chapter aims at the last research question, that is "*What should a supplier provide in terms of services in order to create a superior perceived buyer value?"* Attention remains on this third research question for three consecutive chapters. History and theory of expert systems are provided. Application areas, and benefits of expert systems are discussed; their differences with conventional computer programs are underlined. A comprehensive development process is outlined.

An Expert System Approach for Service Value Creation In Supplier-Buyer Interactions chapter provides the undertaken expert system development. Problem initialization, system analysis & design, rapid prototyping and system development phases of ESSER (Expert System Application for Suppliers to Create Service Value) are provided.

An Application in Automotive Industry chapter provides background information on automotive industry, Turkish automotive industry, and application site and reports basic findings on 39 cases in general, and in detail, on one case.

The *Conclusion and Future Research* chapter discusses the findings, limitations, implications, and future work that extends the present research endeavor. The first section of the chapter provides a detailed explanation of the results obtained in this study. The limitations of the conducted study are then covered, followed by a discussion of contributions of this research. Finally, additional areas of study are identified.

Appendix A, *Logic Blocks of ESSER for Buyer Data,* presents logic blocks used in processing user data on buyer.

Appendix B, *Logic Blocks of ESSER for Supplier Data,* presents logic blocks used in processing user data on supplier.

Appendix C, *Logic Blocks for Deducing Comparative Results,* presents logic blocks used in processing user data to compare operational mediums and provide relevant suggestions.

1.4 Summary

This chapter introduced the thesis by broadly explaining the problem domain. A general background of the topic is provided. Specific research questions were proposed. The importance of this research both from a theoretical and practical standpoint was provided. Finally, the general outline of the thesis was presented.

This next chapter provides a review of literature which is relevant to the study of superior perceived buyer value creation in supplier-buyer interactions upon provision of services in the context of SCM. The major theoretical underpinnings were drawn from supply chain management, value, physics and decision support science disciplines. An extensive literature base is presented to provide a richer foundation for understanding the anatomy of the creation superior perceived buyer value in supplier-buyer interactions upon supplier's provision of services.

2. SUPPLY CHAIN MANAGEMENT (SCM)

This chapter provides a review of prior literature which is relevant to the study of superior perceived buyer value creation in supplier-buyer interaction vie supplier's provision of accompanying services. Since problem domain has received interest from various researchers from different fields of research, an extensive literature base is presented to provide a richer foundation for understanding supply chain management, supplier and buyer interactions, role of services, as well as quality of services. An answer for the first research question is sought in this chapter.

This chapter is organized as follows. The first section covers the relevant supply chain management literature. It also provides a review of history, definition and structures. This is followed by a discussion of supplier and buyer interactions in supply chain management. Next, services component of supply chain management is discussed. The penultimate section covers service quality. Finally, a review of service value creation is provided, with a focus on perceptional subjectivity perspective.

2.1 History, Definitions and Structures

SCM is as old as trade itself, though fostered attention has been devoted only in the recent years. Four eras can be used to describe the evolution of SCM practices: the industrial revolution (1776-1912), the mass production era (1913-1973), the lean manufacturing/quality control era (1974-1995), and the information engineering era (1996-today). Since advances in technology also mark the transitionary milestones in supply chain practices, the time boundaries used are simple approximations based on anecdotal evidence (Siems, 2005).

During the *industrial revolution*, division and specialization of labor was of key importance. Besides, electricity, railroads, transportation and communication should also be emphasized (Poirier, 1999). Markets and opportunities expanded to

unimagined landscapes nurturing new businesses. Work force migrated from farming to manufacturing jobs as wider areas were served by electricity, railroads, transportation and communication. Moreover, as further distances were reachable via advanced means of transportation and communication, globalization had been promoted.

Henry Ford's moving assembly line launched the *mass production* era in 1913. Improving production operations by developing and utilizing capital equipment became predominant. Developed scientific management methods and operations research techniques had been used to define and improve specialized tasks.

Early 1970s staged competition between U.S. and Japanese manufacturers during the *lean manufacturing/quality control* era (Chakravarty, 2001; Taylor and Brunt, 2001). Being proficient was not enough to be superior anymore. Higher quality at lower costs was indeed possible. By improved quality focus and motivation to eliminate defects in supply chains was fostered higher than ever. Just-in-time (JIT) inventory, total quality management (TQM), and enterprise resource planning (ERP) were developed during this era.

Information engineering era began around 1996. Effective uses of the Internet, e-commerce as well as information and communication technologies (ICT) became an industry practice (Geunes et al., 2002). More accurate forecasts of demand requirements, logistics channels, and inventory levels enabled mass production of customized products. Therefore, it is sometimes referred as mass customization era, too. During this era, real-time critical information became accessible by multi-stakeholders of a supply chain. Firms realized that when new ICT were properly used, improvements in services and delivery could be dramatic. As Mentzer et al. state (2001), provision of such services help suppliers in gaining a competitive advantage.

SCM history indicates that focus has shifted from improving internal processes to production and distribution channels with time. SCM operations have been vastly improved by advanced inventory management, streamlined logistics systems, novel approaches to information sharing (i.e., global positioning system (GPS), radio frequency identification devices (RFID), the Internet, and other wireless

telecommunications platforms). Focus has been shifted from inventory to information in the information engineering era. It became less expensive and more accurate to collect, analyze and disseminate information. As a result, inventory levels needed to meet anticipated demand and associated costs have been lowered to the possible minimum levels. Similarly, logistics and other operational costs have been minimized to ever lower levels. As in the case of Dell's Direct Selling, for example, this approach in an extreme employment has even made zero stock levels possible for the later stakeholders of the supply chain (Dell, 2000). Information that became available in this era also facilitated improvements in untouched areas of SCM, particularly by decision support systems.

Internal functions including transformation processes, upstream suppliers and downstream distribution channels until the end customer, including the distributors and retailers are involved in a supply chain, (Handfield and Nichols Jr., 2002) where the ultimate goal is to transform raw materials into value added finished products (Bhaskaran, 1998) that are ready to be consumed by end users. Even though the term Supply Chain Management is popular in academia and practice, there is a substantial confusion regarding its meaning. Some definitions involve operational terms regarding flow of materials and products, where as others consider it as a management philosophy or view it as a management process (Tyndall et al., 1998). There appears to be various definitions for the term *supply chain management*'s definition (Kauffman, 2002; Lummus et al., 2001; Mentzer et al., 2001; New, 1997). In this research, the researcher has decided to use the definition proposed by (Simchi-Levi, 2003):

"Supply chain management is a set of approaches used to efficiently integrate suppliers, manufacturers, warehouses, and stores so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time in order to minimize system wide costs while satisfying service-level requirements".

In this context, this research endeavor adopts a services perspective and investigates the supplier-buyer interactions in terms of services integrated in the delivery of hybrid goods.

2.2 Supplier and Buyer Interactions in Supply Chain Management

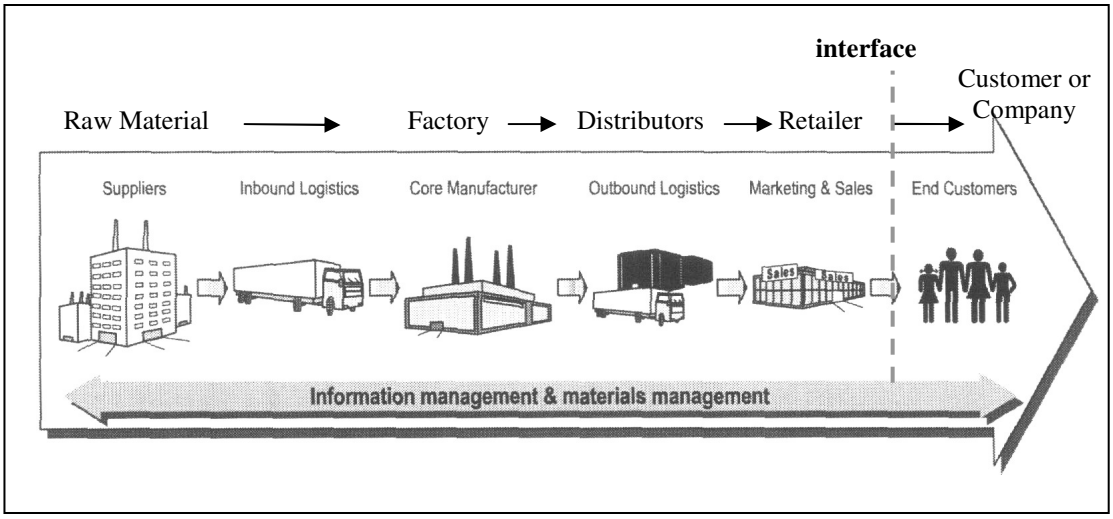

Figure 2.2.1. Linear architecture of a supply chain (Chan et al., 2003, p.638)

A typical supply chain involves buyers, which are often depicted as the sole reason for the whole chain (Figure 2.2.1). Any stakeholder in a supply chain looks forward to meeting the requirements of its buyers. One common practice often emphasizes the interface between the end user and the serving supplier, and focuses only at the supplier-buyer interaction taking place here. However, real industrial practices involve numerous interfaces whenever there's a buyer and a supplier, for example, between a supplier and an inbound logistics, between an inbound logistics and core manufacturer, between a core manufacturer and an outbound logistics, between an outbound logistics and marketing & sales in addition the interaction between the marketing & sales and end customers. At each interface an interaction between a buyer and a supplier takes place. In usual practice, the physical product follows the pathway designated by the arrows (Figure 2.2.1), moves from left to right. On the contrary, financials follow a reverse direction. By the aid of developed ICT tools, shared information facilitates a two-way dissemination. To better comprehend supplier-buyer interactions, the value additive processes taking place, it is of vital importance to consider contributions of all three as well as other tangible/intangible factors that might take place. For example, value additive processes are better comprehended by observing the reverse flow.

For a firm to gain and retain value additive beneficial relationships with its buyers, its offer should often involve some social values (something that will make buyer's

life a better one) either by clearly identifying the needs of its buyers or by outperforming what other suppliers already do. In other words, if we examine speed of delivery, a supplier can create added value at its buyer only by delivering speedier than the competition. Alternatively, rather than delivering at any time like the competition, if a supplier can aid its buyers scheduling by being prompt in terms of hours of delivery on a given day, it could also create added value. When the investigated concept is a tangible one, it is relatively easy to set benchmarks for comparing alternatives. However, discussing value adding intangible concepts, the determination of benchmarks becomes troublesome.

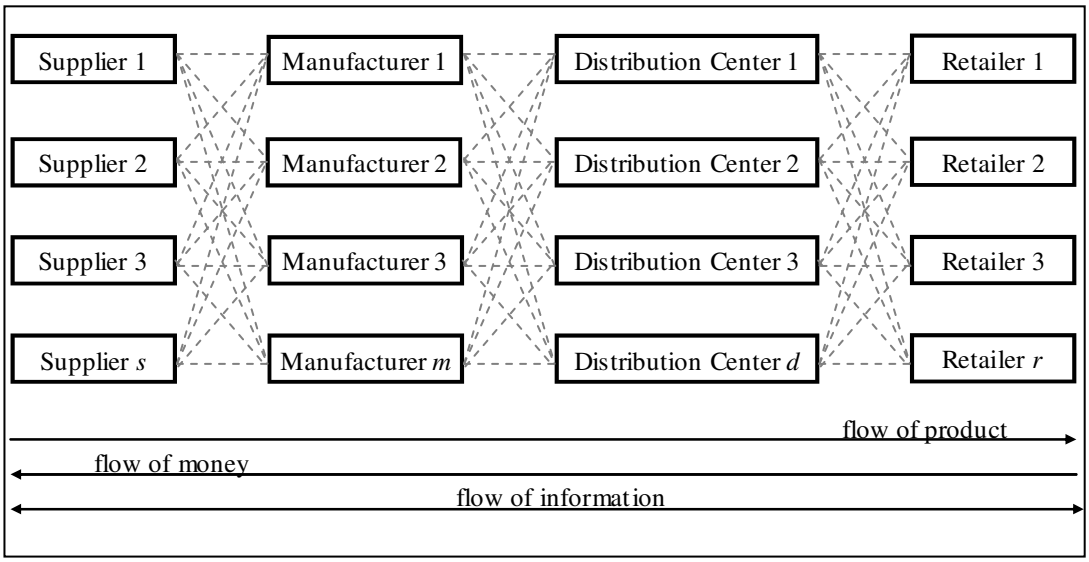

Figure 2.2.2. Supply chain with numerous stakeholders

Real life practices of supply chains are more complex than the above depiction (Figure 2.2.1) with many sources of raw materials, plenty of distributors, many retailers receiving products. For example, supplier 1 can deliver to both manufacturers 1 and 2, while manufacturer 2 can deliver to distribution centers 2 and 3, and distribution center 2 can deliver to retailers 2 and 3, instead of supplier 1 delivering to manufacturer 1, manufacturer 1 delivering to distribution center 1, and distribution center 1 delivering to retailer 1. This new structure facilitates a change in placing the interface. Mirroring real practices, interface and supplier-buyer interactions can take place anywhere a buyer interacts with a stakeholder(s) of the supply chain. Indeed, some authors argue that such complex structure could be better envisioned as a network rather than a chain, and propose the term "value network"

to be used as a contemporary common term describing supply chains (Chang, 2004; Talluri and Baker, 2002).

2.3 Service Component of Supply Chain Management

"Getting a defect-free product to the customer faster and more reliably than the competition is no longer seen as a competitive advantage, but simply a requirement to be in the market. Customers are demanding products consistently delivered faster, exactly on time, and with no damage" (Mentzer et al., 2001). Taken all together, these necessities demand closer coordination and better alignment between supply chain participants, hence, better understanding of supplier-buyer interactions. As the Simchi-Levi's (2003) definition introduced in Chapter 2.1 suggests, the areas of focus in supply chain management are; (1) minimizing system wide costs, and (2) satisfying service-level requirements; via set of approaches used to efficiently integrate suppliers, manufacturers, warehouses, and stores. Production and distribution of merchandise at the right quantities, to the right locations, and at the right time had been thoroughly researched and system wide costs has been reduced to the possible levels by advanced tools, leaving the service-level requirements as a fertile area for firms and researchers (Bitran et al., 2003; Johnston, 2004).

As "service quality is an elusive and abstract construct that is difficult to define and measure" (Cronin and Taylor, 1992), so is defining service expectations (Bitran et al., 2003) of buyers which serves as the basis for their service-level requirements. Managers face great challenges in formulating adequate levels of service provision that is capable of meeting their each individual buyer, which they are involved with in a supply chain. Advanced tools are yet to be designed for further enhancing the topic. First, the instantaneous provision of services should be investigated by magnifiers and then the anatomy of buyer value creation and its relation with services should be examined. The stiff competition kept on diminishes supply chain management's satisfaction from the adoptation of low system wide costs, complex service-level requirements become a concern for designing improved competitive SCM strategies. The though contemporary marketplace competition forces firms to look for novel ways. In its simplest form, SCM is considered as a trade-off between costs and services (Barsky and Ellinger, 2001; Robinson et al., 1993). Provision of

higher levels of services launches new cost accounts. On the other hand, companies refrain from all sorts of costs to survive the rivalry. Though both is a must, higher service levels and lower cost levels, studies focusing on optimized service levels have a limited scope. Mathematical approaches that claim superiority upon inclusion of service factors often define complex service-levels only in relation with stock outs (Graves et al., 1998; Lee and Billington, 1993; Minner, 2003; Newhart et al., 1993; Pyke and Cohen, 1994; Talluri and Baker, 2002). While breakdown for costs of all sorts are available, the sketchy examination of services presents an untouched problem area. Usually firms who seek for novel ways to improve their supplier activities promote higher levels of services to all of their buyers. However, such an approach involves tremendous costs. A tool via which suppliers could have analyzed their service provisions' standings with respect to the service level requirements/expectations of their buyers could have helped the expanding optimization improvements. For example, Metaxiotis (2005) stresses the importance of services focused research and suggests use of Expert Systems for improved approaches to be developed.

Literature review has directed the researcher towards services dimension of supply chains for the deemed fertility. Today's supply chain management calls for operational strategies for existing supply chains and focuses on differentiation via service-orientation for enhancing competitive edge. It has been identified that services play an important role in determining competitiveness due to minimum system wide costs granted by the aid of highly advanced mathematical models. *Ceteris paribus,* services that accompany an encounter has been claimed to be of key importance in shaping the perceived buyer value, which in turn expected to improve supplier's competitiveness (Barsky and Ellinger, 2001; Lapierre, 2000; Ulaga, 2003; Woodruff and Gardial, 1998).

Taking all the discussion above, the following Research Questions have been designed in order to drive the upcoming phases of this research: "*Does supplier's provision of services generate superior or inferior perceived buyer value?",* if so "*Why does provision of services within a supply chain create superior perceived buyer value?",* and lastly linked with these, "*What should a supplier provide in terms of services in order to create a superior perceived buyer value?"*

In this context, services should be defined in order to attempt at the research questions. An early definition may help to dispel a number of misconceptions about what services are: "*Most authorities consider the services sector to include all economic activities whose output is not a physical product or construction, is generally consumed at the time it is produced and provides added value in forms that are essentially intangible concerns of its first purchaser*" (Quinn et al., 2003). There is basic agreement about a number of characteristics of services. To start with, it is generally assumed that, unlike goods, services are not physically tangible. This quality is illustrated by the pragmatic description from The Economist, according to which a service is "anything sold in trade that could not be dropped on your foot" (UNCTAD/WorldBank, 1994). Usually it's easier to define what services 'are not', than to define what services 'are'. Services are often fully or substantially intangible. If entirely intangible, they are exchanged promptly between the producer and the buyer, without any storage opportunities and total perishability. Since they are produced, bought and consumed momentarily, it is usually difficult to identify services. Typically, inseparable intangible elements are engaged, buyer has an indispensable role in performing of the encounter, ownership or transfer of rights is out of question. On the other hand, contemporary products are commonly partly tangible and partly intangible. These common, hybrid forms, inherit most of the attributes of services but not necessarily fully. In addition, activities performed by sellers and others that accompany the sale of a product and aid in its exchange or its utilization are also referred as services. Characteristically such activities supplement the product, if performed pre- or post-sale, but perceived as an intangible part of the product when performed during the sale (Zeithaml et al., 2002).

The difficulty mostly lies in the intangibility (at least substantially) and perishability of the services, let alone the non-standardability aspect arising from the human factor of performer. In addition, the diverse forms of services add to this trouble. Every day, a new type of a services business gets introduced to the lives of millions mostly due to the improvements in technologies (Internet Service Providers, GSM Operators). Even General Agreement on Trade in Services refrains from declaring a restricted description of services, because it doesn't want to limit to scope to today's known boundaries, and at the same time welcomes new types of services created every day by the advancing technologies (I.G.E.M.E., 2004). Technology also

changes the perceptions of jobs, i.e., today product design is considered more as a hybrid of services and manufacturing, rather than a pure manufacturing operation (Bitran et al., 2006). To emphasize the scale and scope of this hard to define concept, a glance at the monetary standing would be sufficient. The share of services in Turkey's GDP stands around 60-70% for the last 4 years (T.C.M.B., 2007).

A simplifying approach for defining services in supply chains would focus on activities taking place at interfaces with the buyer, as well as on operations undertaken on behalf of the buyer. For example, a typical manufacturing operation would undertake a wide range of positive decisions and actions on behalf of the end users, but without directly engaging them, with a certain degree of freedom. On the other hand, service operations have to engage the buyers either directly or indirectly for the value additive activities to be performed. In this framework, expert systems might also be used to promote direct engagement of buyers.

2.4 Service Quality

Industrial Revolution introduced a shift from centralized to decentralized network structure. Economies of scale and management made supply chains more vertically integrated, while a few countries that hold most of technological innovation, catalyzed the process. This trend persisted for a long time, until calculating dollar figures on the costs of complexities in management became possible. In addition, development and transfer of technology economically enabled wide supply chains, and overcame international obstacles against trading. Today, whenever it's economically more feasible, companies outsource various functions to locations and to markets. In a way, a reverse mechanism operates for a shift from centralized to decentralized networks. Yet, the issue of the dollar cost on complexity preserves its standing with this new trend. Trend towards decentralized operations also brings about a change for service-level requirements and supply chain cost control responsibilities. Though, a glance at the situation would suggest that CEO and his/her organization are equally responsible for cases of vertically integrated firms, a deeper look would catch that even defining such roles and responsibilities is a fundamental and critical challenge both for supply chain participants, and for the health of global economy.

Decentralization of supply chains defines a new strategic challenge for individual firms in the value networks, that is, emphasizes the role of services component evenly with those of manufacturing and coordination components (Figure 2.4.1). The areas for individual firms to differentiate themselves are limited than ever by the trend of decentralized mode of operations. Within its own reach of influence, it is possible for a firm to distinguish itself via service-oriented approach. Such an application would enhance buyer benefits within the network, and would preserve a competitive edge by delivering perceived added value through services in a profitable and efficient way. In highly competitive superior service industries like automotive industry (Barsky and Ellinger, 2001), rather than limiting promotional efforts to the products they offer, companies promote value-added services in which those physical products are embedded. For instance, "companies that provide car parts have little choice but to compete on service" that creates superior perceived buyer value (Barsky and Ellinger, 2001). Providing improved service to buyers is a matter of understanding current level of provided services, and improving from there on. Because of this complex stemming, all intentions of delivering improved services rely more or less on other stakeholders inside the supply chain, and sometimes even on competitors.

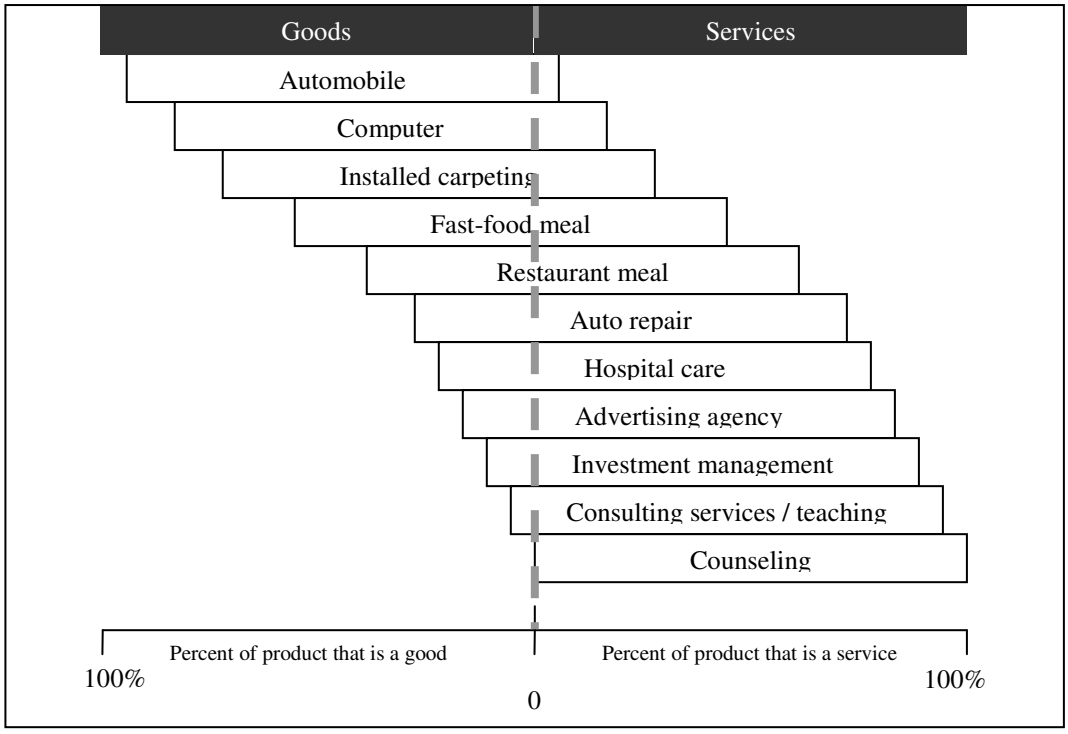

Figure 2.4.1. Hybrid goods (Heizer and Render, 2000, p.13)

Quality of services, founded on a comparison between what the buyer feels should be offered and what the supplier provided (Pitt et al., 1995), can be measured on ten dimensions; (1) tangibles, (2) reliability, (3) responsiveness, (4) competence, (5) courtesy, (6) credibility, (7) security, (8) access, (9) communication, (10) understanding the customer (Berry et al., 1990). Service-level requirements, expectations and performances of supplier and buyer couples of supply chains are often expected to be also formed via these ten dimensions (Parasuraman et al., 1985):

Tangibles include the physical evidence of the service such as (1) physical facilities; (2) appearance of personnel; (3) tools and equipment used to provide the service and (4) physical representations of the service. McDoughall and Snetsinger (1990) refer to tangibility as "the degree to which a product or service can provide a clear concrete image". They also imply that, through stressing tangible cues and making communications more vivid, management can address intangibility. Therefore, service providers focus on making services more tangible to influence customers' decision-making so that they can grasp and evaluate a service on beforehand (Johns, 1999; McDoughall and Snetsinger, 1990; Rushton and Carson, 1989).

Reliability involves consistency of performance and dependability, meaning that the supplier performs the service right the first time besides honoring its promises. Specifically, it involves (1) accuracy in billing; (2) keeping record correctly and (3) performing the service at the designated time. It is the ability of the firm to perform its assigned task predictably and without failure at all times. High service reliability is the flawless performance of a prespecified service (Galetzka et al., 2006).

Responsiveness involves timeliness of service and concerns the willingness or readiness of employees to provide service. *Mailing a transaction slip immediately*, *calling the customer back quickly* and *giving prompt service* are some examples.

Competence means possessions of the required skills and knowledge to perform the service. It involves (1) knowledge and skill of the contact personnel; (2) knowledge and skill of operational support personnel and (3) research capability of the organization (Cox and Dale, 2001).

Courtesy involves politeness, respect, consideration, and friendliness of contact personnel. It includes (1) consideration for the consumer's property and (2) clean and neat encounters (Johnston, 1995).

Credibility involves trustworthiness, believability, honesty. It involves having the buyer's best interests at heart. Contributing to credibility are (1) company name; (2) company reputation; (3) personnel characteristics of the contact personnel and (4) the degree of hard sell involved in interactions with the buyer.

Security is the freedom from danger, risk or doubt. It involves (1) physical safety; (2) financial security and (3) confidentiality (Ghobadian et al., 1994).

Access involves approachability and ease of contact. It means (1) the service is easily accessible by means of technology; (2) waiting time to receive service is not extensive; (3) convenient hours of operation and (4) convenient location of service facility.

Communication means keeping customers informed in language they can understand and listening to them. It may mean that the company has to adjust its language for different buyers – increasing the level of sophistication with a well-educated buyer and speaking simply and plainly with a novice. It involves (1) explaining the service itself; (2) explaining how much the service will cost; (3) explaining the trade-offs between service and cost and (4) assuring the consumer that a problem will be handled.

Understanding the buyer involves making the effort to understand the buyer's needs. It involves (1) learning the customer's specific requirement; (2) providing individualized attention and (3) recognizing the regular customer.

Service quality dimensions that are discussed above for measuring buyer's perceptions of service quality have also been used by SERVQUAL, a multi-item instrument, developed by Parasuraman, Zeithaml, and Berry (Parasuraman et al., 1985). Though original SERVQUAL has the ten dimensions listed, the revised instruments has five dimensions which are tangibles, reliability, responsiveness, assurance and empathy (Parasuraman et al., 1988). There are numerous critics of the SERVQUAL (van Dyke et al., 1999). Though SERVQUAL proves to be useful in

some instances, it becomes really limited in formulating a strategy before service provision. This is due to three main factors. Firstly, it measures the gap between the expectations before service delivery and perceptions after service delivery. Therefore, the measured service quality is only available after the provision of services. Secondly, even though it is widely accepted that services are co-produced by the buyer and the supplier, SERVQUAL only considers buyers expectations and perceptions. Thirdly, SERVQUAL's use is limited just as a measurement instrument. It does not provide any suggestions to service providers for reducing the gap, or neither informs them how their improved services could be perceived by their buyers. Despite all these downsides, research formulated around SERVQUAL informs service quality related initiatives about the important and useful service quality dimensions, which are widely used by academics and practitioners to measure service quality (van Iwaarden and van der Wiele, 2003).

Services are like the glue that holds together the supplies of a firm. Like the reinforcement applied to the concrete, services introduce composite structure to a supply chain. Services contribution to operations can be contended as similar to that of small scale impurities, which are present in the atomic structure of any material. Such adds strength, ductility while reducing brittleness, when applied at correct proportions (Callister, 2003).

Services are deeds, performances, and procedures. The often cited main characteristics of services include intangibility, heterogeneity, simultaneous production and consumption, and perishability (Zeithaml et al., 2002). In the contemporary business world, pure services or pure products are rarely seen, but a combination is a common practice. Indeed, it is this combinatorial structure that differentiates a firm from the competition.

2.5 Service Value Creation

A common characteristic of services that is often visited is the "subjectivity" inherited and the linked possibilities of generating added value. In the dyadic relation among a supplier and a buyer, the buyer holds a set of expectations regarding what the supplier should perform. When the supplier performance meets or exceeds the

expectations of the buyer, only then perceived buyer value generation would become possible. Contrary to being easily said, supplier faces a great challenge as usually there is limited information readily available about the expectations of its buyer prior to the encounter. However, it is often these unsolicited expectations that determine the service-level requirements for the buyer. Such expectations are usually influenced from prior experiences, and shared knowledge. In a supply chain, one would expect the long-term relations and contracts to build trust and mutual understandings about service-level requirements. When service-level requirements exceed the boundaries of "stock out rates" and include real services that accompany delivered products, the subjectivity also becomes a factor. Moreover, what would be considered as a *normal service-level performance* shall also be subject to change with an upwards trend in today's highly competitive global business environment. The services focus competition raises the bar each and every day by making some luxuries of past standards of today. As prior experiences with a service encounter increases, the expectations for the next encounter gets more solid and new level of expectations are determined for future services.

Service-level requirements are shaped by expectations, and expectations are often built by experience, and/or knowledge. In addition, expectations of a buyer from its supplier are also cultivated by the dynamics of the business environment but not only by the steady relations of the supplier-buyer couple. A firm, whether it is a supplier or buyer, undertakes various operations with numerous firms in its periphery. The stakeholders of a firm's periphery provide continuous information to the firm, and thus shape the understanding about a particular service. Some firms appear to have more advanced services knowledge and experience, and depending on their role in a supply chain, they either perform or expect higher service-level requirements. On the other hand, some firms understanding of services appear to be at infancy. This secondary group often carries lower service-level requirements in their agenda both as a buyer and a supplier.

Buyers' product, services, and providers of product and services preferences are heavily shaped by how well they create value for them. Buyer value is the measure of a supplier's contribution to its buyer, based on the entire range of products, services, and intangibles that constitute the company's offerings (Simchi-Levi,

2003). In recent years, this measure has superseded measures such as quality and customer satisfaction as firms often wish to exceed (or at least fulfill) buyers' expectations to provide value (Table 2.5.1).

Table 2.5.1. Key supply chain management issues

	Global Optimization	**Managing Uncertainty**
Network Planning	*	
Inventory Control		*
Supply Contracts	*	
Distribution Strategies	*	*
Strategic Partnerships	*	
Outsourcing and Procurement		*
Product Design		*
Buyer Value	*	*
Information Technology	*	*

Source: (Simchi-Levi, 2003, p.17)

Comprehending what is a buyer's value can be extremely difficult, and often multidimensional. In his review of literature, Woodall (2003) analyses ninety articles published during the last fifteen years in the fields of marketing, strategy and operations management. He documents eighteen different names (i.e., customer value, perceived buyer value, perceived value, value, consumption value, value for the customer(s), customer perceived value, consumer value, perceived customer value, buyer value, service value, consumer surplus, expected value) for similarly-described notions of value. One relatively comprehensive definition of perceived buyer value is "perceived performance for and evaluation of those product attributes, attribute performances, and consequences arising from use that facilitate (or block) achieving the buyer's goals and purposes in use situations" (Woodruff and Gardial, 1998). The idea of a trade-off is included in the value concepts of buyer, i.e., same price but higher quality, or fewer sacrifices with more benefits. Similarly, buyers participating in a supply chain are usually concerned with a trade-off, but between functional, service, and relationship benefits, and monetary and non-monetary sacrifices as these relate to certain goals (Lapierre, 2000; Ulaga, 2003). In this research's context, value refers to the specific quality of a service as perceived by buyers in relation to their needs, such as the speed or quality of performance on a new task or the aesthetics or performance features of a new product. Often visited

three ways for supply chain management to generate perceived buyer value are (1) effectiveness, (2) efficiency and (3) differentiation. Here, supply chain effectiveness refers to the level of performance or service provided; efficiency deals with the return on resources committed to supply chain activities or the level of cost control achieved; and differentiation refers to the uniqueness of the process being utilized (Barsky and Ellinger, 2001).

Whether a firm has an advanced or infant standing in terms of service-level requirements is mainly determined by its operational medium, which is amalgamated by the services related knowledge and experience the stakeholders in its periphery have. Researcher has contended that the firms' operational medium is the main influencer in determining whether an encounter would in fact create a superior perceived buyer value. Hence, the first research question that drives this research has been investigated thoroughly.

2.6 Summary

This chapter introduced a review of literature which is relevant to the study of superior perceived buyer value creation in supplier-buyer interactions upon provision of services. History, definitions and structures of supply chains were provided. This is followed by a discussion about the supplier and buyer interactions in supply chain management. Next attention is devoted to services component of supply chain management. Penultimate section covers service quality. Finally, the service value creation was presented. Overall, the first research question, "*Does supplier's provision of services generate superior or inferior perceived buyer value?",* has been investigated. In relation with this, following second research question, "*Why does provision of services within a supply chain create superior perceived buyer value?"* is to be investigated in the next chapter.

This next chapter provides a review of Snell's Law which is relevant to explanatory model building and presents the analogy to explain superior perceived buyer value creation in supplier-buyer interactions upon provision of services.

3. SERVICE VALUE CREATION IN SUPPLIER-BUYER INTERACTIONS: MIRRORING SNELL'S LAW

Among emerging optimization techniques, there is one infamous memory-less optimization technique known as Simulated Annealing (Onwubolu, 2002). The simulated annealing approach is established on a Monte Carlo model, which is used for examining annealing process of a material in terms of the relationship between atomic structure, entropy and temperature (Van Laarhoven and Aarts, 1987). Annealing is a heat treatment process at which shaped metal materials are first heated to a suitable temperature, hold at that temperature for a specific time, and then cooled slowly according to a pre-determined schedule. Via annealing, certain mechanical properties of a metal material can be improved. For example, hardness and brittleness can be reduced, microstructure can be altered in favor of desired outcomes, machinability and formability can be granted by softening, strain hardening or re-crystallization can be ensured, or residual stress can be relived. Certain analogies exist in formulating simulated annealing. Combinatorial optimization problem is treated as transformation of the solid metal form the initial to the final state. The objective function corresponds to the energy, where the control parameter is resembled by the temperature. Services creation of value has an instantaneous nature like that of the passage of a beam of light from one medium to another one. Before proceeding to the dynamics of theory application, a basic understanding of the physics law that'll be utilized for the purpose of this study will be explained. Snell's Law, which explains behavior of light in different mediums, will be utilized in order to provide a fruitful framework for understanding service-oriented differentiation efforts and creation of superior perceived buyer value for added value among supply chains. Tough similar applications from basic natural sciences to various managerial issues had been practiced in the past; this research has been the first one to enrich the field by an analogy from Snell's Law.

This chapter provides background information on Snell's Law, which explains behavior of light as it passes through different mediums. Behavior of light in different mediums contains tremendous amount of information that can be used to deduce the dynamics of supply chains by the aid of management science.

This chapter seeks an answer to the second research question, "*Why does provision of services within a supply chain create superior perceived buyer value?",* that drives this research and is organized as follows. The first section extends Snell's Law. This is followed by an analogy to the supplier and buyer interaction, where an explanatory research model is built. Finally, findings from panel of experts are presented in discussing the meaningfulness and usefulness of the built model.

3.1 Snell's Law

Certain properties of light characterize its behavior as a wave (Figure 3.1.1). These are: (1) **amplitude** or intensity (how strong is it); (2) **wavelength** (distance between "crests"), or similarly, frequency (how many crests pass a given point every second). Wavelength determines the *type* while amplitude determines the *intensity* of light (Beiser, 2002).

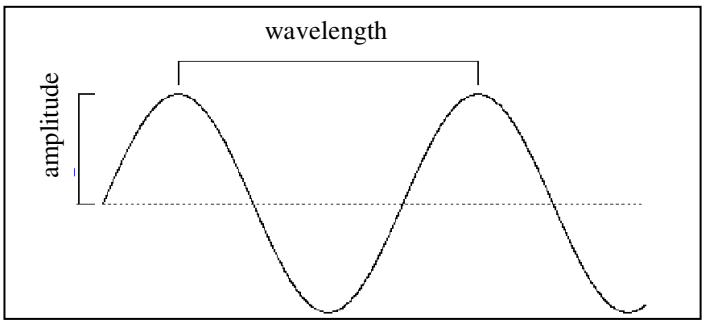

Figure 3.1.1. Behavior of light beam as a wave

When movement of light is discussed, reference is usually made to the speed of light in a vacuum, which is (3.00 x 108 m/s) and referred as *c*. When light travels through different mediums, such as glass, diamond, or plastic, it travels at a different speed. The speed of light in a given material is related to a quantity called the index of refraction, η, which is defined as the ratio of the speed of light in vacuum (c) to the speed of light in the medium (ν_m):

Index of refraction: $\eta = c / v_m$ (9.1.1)

Index of refraction is directly proportional with the density of the medium the light is traveling through. Therefore, generally speaking, gases have a lower index of refraction due to their thinner structure, while liquids have higher index of refraction. Actually, this also explains "why rainbows enlighten your day only when it rains?", and "why scuba divers cannot see the sky? (Also known as total internal reflection)"

When light travels from one medium to another, the speed changes, as does the wavelength. The index of refraction can also be stated in terms of wavelength:

$$\eta = \frac{\lambda}{\lambda_m} \quad (9.1.2)$$

where λ is the wavelength in vacuum and λ_m is the wavelength in the medium *m*.

Although the speed and wavelength changes, frequency of light stays constant. The frequency, wavelength, and speed are related by:

$$v = f \times \lambda \quad (9.1.3)$$

The change in speed that occurs when light passes from one medium to another is responsible for the bending of light, or refraction, that takes place at an interface. If light is traveling from medium 1 into medium 2, and angles are measured from the normal to the interface, the angle of transmission of the light into the second medium is related to the angle of incidence by Snell's Law.

Snell's Law : $\eta_1 \times Sin\theta_1 = \eta_2 \times Sin\theta_2$ (9.1.4)

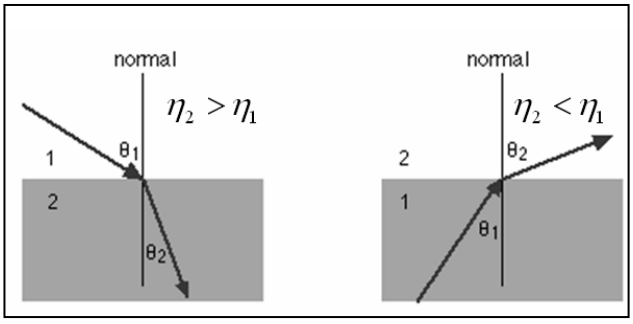

Figure 3.1.2. Light traveling between two mediums with different index of refraction

When light crosses an interface into a medium with a higher index of refraction, it bends towards the normal (Figure 3.1.2). Conversely, light traveling across an interface from higher n to lower n will bend away from the normal (Figure 3.1.2). This has an interesting implication: at some angle, known as the critical angle, light traveling from a medium with higher n to a medium with lower n will be refracted at 90°; in other words, refracted along the interface. If the light hits the interface at any angle larger than this critical angle, it will not pass through to the second medium at all. Instead, all of it will be reflected back into the first medium, a process known as total internal reflection.

3.2 Analogy to Supplier Buyer Interaction

Borrowing from Snell's Law of physics, following are assumed in terms application:

Every incident of an encounter within a supply chain shall be a light beam traveling from one medium (supplier) to another medium (buyer firm). Service value creation is indeed very similar in nature to a light beam traveling from one medium to another as they are both instantaneous.

Whether a firm has an advanced or infant standing in terms of service-level requirements is mainly determined by its operational medium, which is amalgamated by the services related knowledge and experience the stakeholders in its periphery have. Operational medium shall replace index of refraction in Snell's Law, i.e., a firm which maintains higher service-level requirements has a higher index of refraction (like liquids), and vice versa. The behavior of light as it comes from one medium and goes to another medium, where these mediums have different indices of refraction is used to illustrate transfer of services from supplier's operational medium to that of the buyer.

The interface plotted in Figure 2.2.1 (where a supplier – buyer couple interact) shall be deemed to stand in between two different operational mediums, i.e., every hybrid good supply encounter takes place in between two parties with relatively different operational mediums (indexes of refraction). By definition, for a supplier to preserve its place within a supply chain, it has to be performing at least the specifics of the buyer. Therefore, conditions examined in this research do not cover areas of poor

performance, but only those where the supplier is intentionally trying to generate perceived buyer value.

A beam bending towards the normal upon entering a new medium with a different index of refraction shall resemble a perceived buyer value of inferiority (Figure 3.2.1).

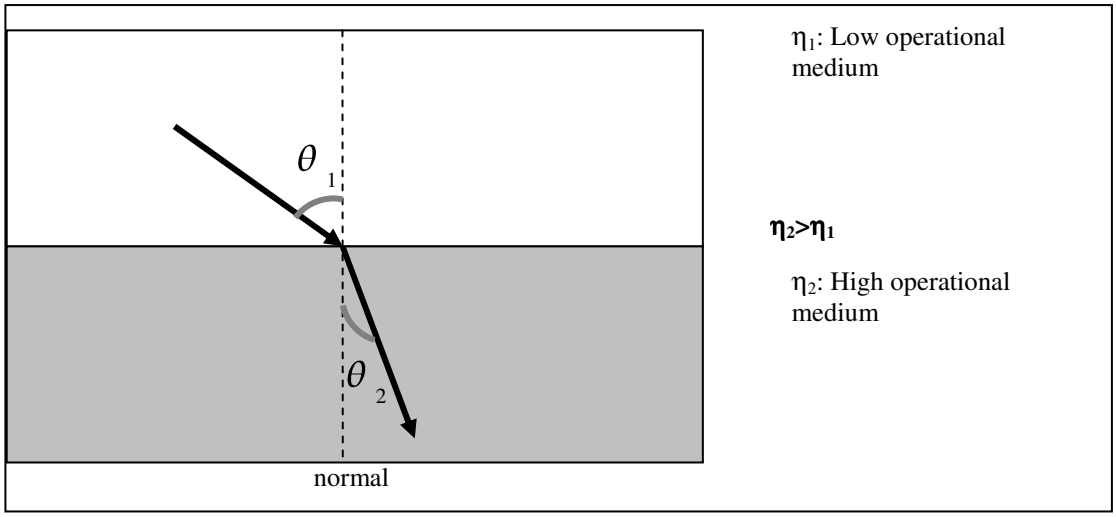

Figure 3.2.1. Hybrid good supply from a low operational medium supplier (low service-level) towards a high operational medium buyer (high service-level)

A beam bending away from the normal upon entering a new medium with a different index of refraction shall resemble a perceived buyer value of superiority (Figure 3.2.2).

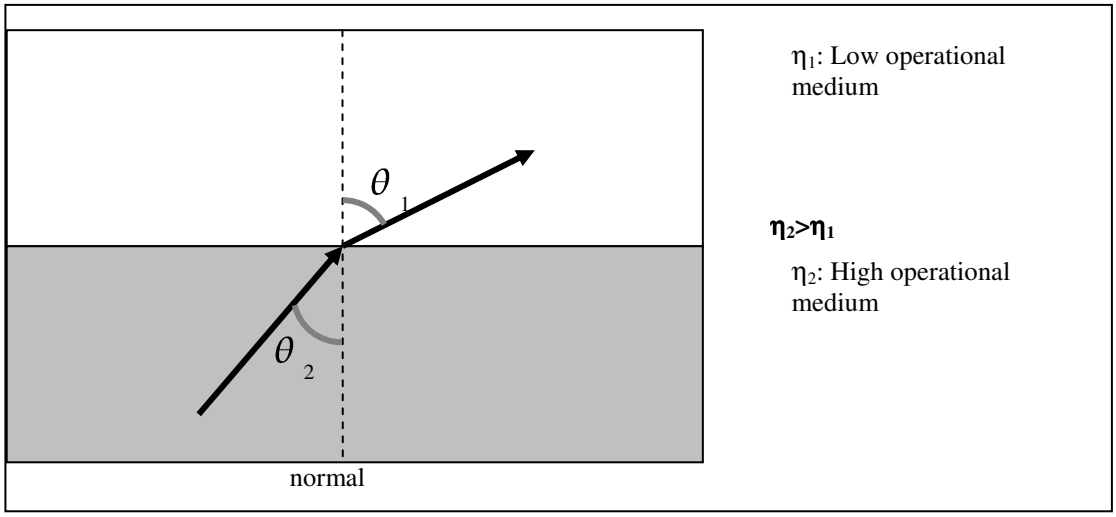

Figure 3.2.2. Hybrid good supply from a high operational medium supplier (high service-level) towards a low operational medium buyer (low service-level)

Neither the buyer's nor the supplier's operational medium by itself is deemed to be capable of yielding to perceived buyer value, but a comparative standing of the buyer's operational medium against the supplier's. A comparison between what the buyer feels should be offered and what the supplier attempts to provide (Pitt et al., 1995), can be measured on ten dimensions; (1) tangibles, (2) reliability, (3) responsiveness, (4) competence, (5) courtesy, (6) credibility, (7) security, (8) access, (9) communication, (10) understanding the customer (Berry et al., 1990) as this research defines operational medium by the amalgamated the services related knowledge and experience a firm's stakeholders in its periphery have. In addition, often visited three ways for supply chain management to generate perceived buyer value include (1) effectiveness, (2) efficiency and (3) differentiation. Here, supply chain effectiveness refers to the level of performance or service provided; efficiency deals with the return on resources committed to supply chain activities or the level of cost control achieved; and differentiation refers to the uniqueness of the process being utilized (Barsky and Ellinger, 2001).

To summarize, in order to compare supplier's and buyer's densities of operational mediums and determine conditions that yield to;

- [Supplier's Operational Medium > Buyer's Operational Medium] ➔ superior perceived buyer value

- [Supplier's Operational Medium< Buyer's Operational Medium] ➔ inferior perceived buyer value

(Meanwhile, "Supplier's Operational Medium = Buyer's Operational Medium" case is not considered among alternatives since such a case is not value additive due to operational medium analogy.)

, following *conceptual design* has been built by mirroring Snell's Law and drawing upon SCM literature (Figure 3.2.3).

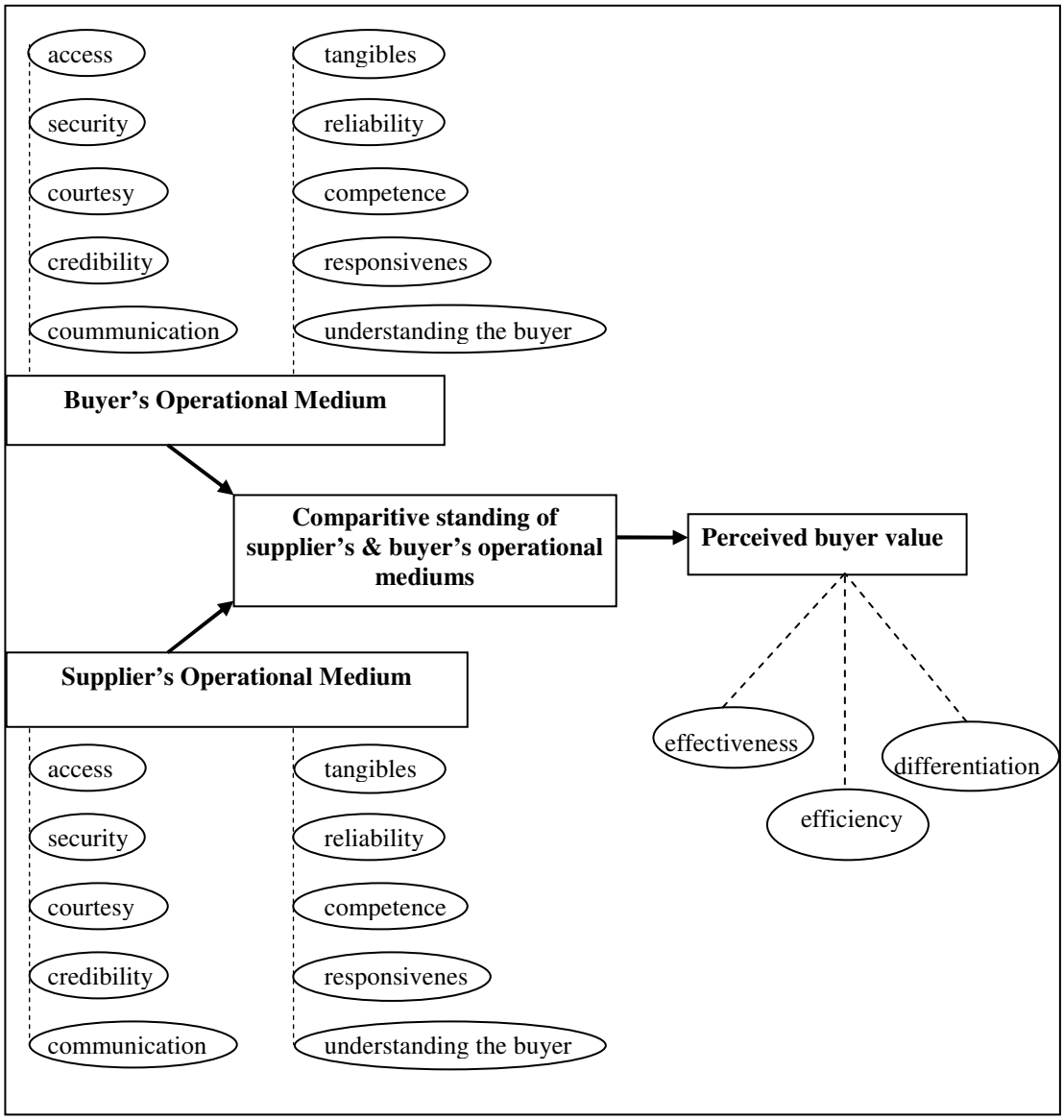

Figure 3.2.3. Explanatory research model

Following propositions that shed the light for future planning stages, have been derived from the exploratory model:

Proposition I:

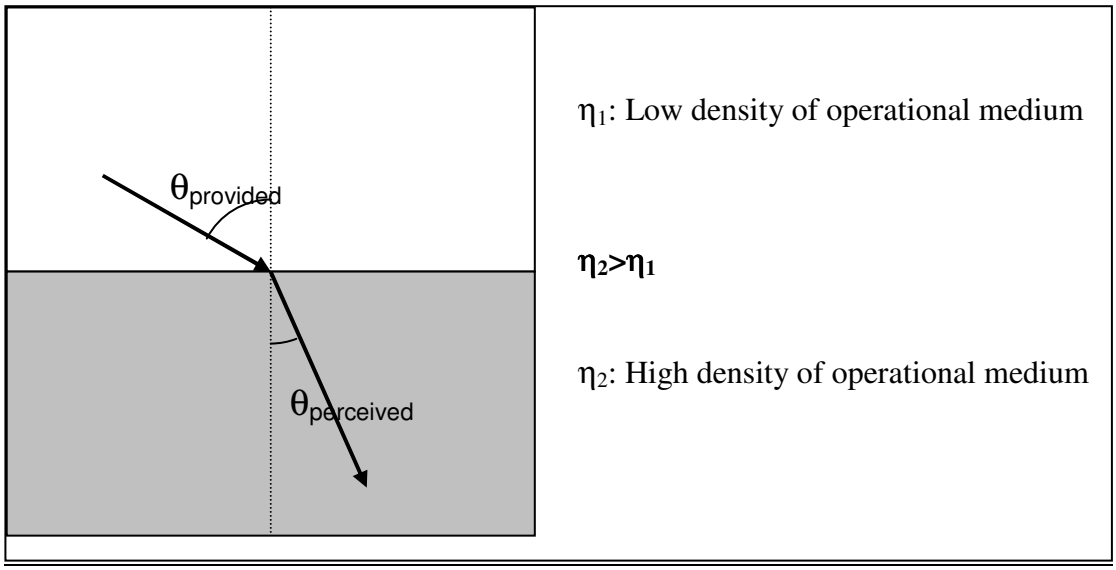

Figure 3.2.4. Illustration for proposition 1

P1: Lower operational medium on supply side is likely to cause *inferiority* in perceived buyer value for an encounter (Figure 3.2.4).

$$\theta_{\text{provided}} > \theta_{\text{perceived}} \qquad (9.1.5)$$

Proposition II:

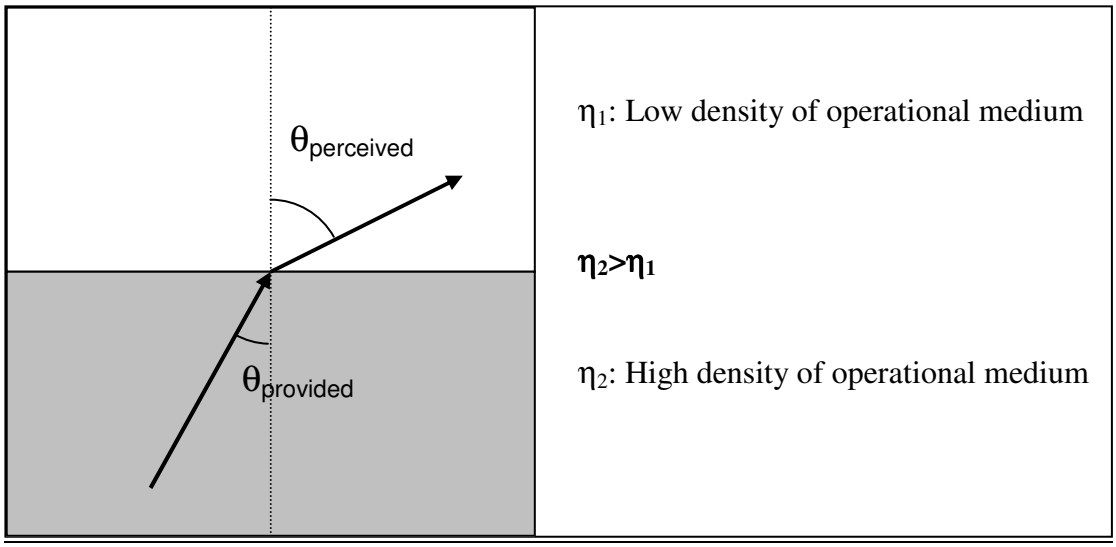

Figure 3.2.5. Illustration for proposition 2

P2: Higher operational medium on supply side is likely to cause *superiority* in perceived buyer value for an encounter (Figure 3.2.5).

$$\theta_{\text{perceived}} > \theta_{\text{provided}} \qquad (9.1.6)$$

Following section presents the panel of experts conducted in order to confirm the usefulness and meaningfulness of the developed exploratory model.

3.3 Panel of Experts

The research process for the panel of experts was a qualitative technique based on an interpretive orientation. This approach focused on understanding the underlying meanings of participants' expressions about creation of buyer value upon provision of accompanying services, their perspectives, and world views (Berg, 2001). The intent of the researcher was to understand the extent that the built exploratory model would be useful and meaningful through the knowledge and experience of selected interviewees. Sampling was purposive (Berg, 2001), and individuals were selected to represent a constituency comprising Turkish automotive sector's supply managers in line with Barsky's (Barsky and Ellinger, 2001) point of view conveyed in Chapter 2.4. Participants included 9 provincial individuals (Table 3.3.1).

Table 3.3.1. Panel of experts' interviewees

Interviewee No	**Years of Experience**	**Responsibility**
1	11	Spare Parts Logistics Specialist
2	12	Spare Parts Logistics Specialist
3	4	Spare Parts Logistics Specialist
4	8	Supplier Relations Specialist
5	15	Spare Parts Logistics Department Manager
6	9	Regional Sales and Relations Manager
7	6	Supply Parts Brand Manager
8	7	Quality Assurance Dealer
9	3	Spare Parts Logistics Specialist

In all, there were 19 interviews, involving 9 individuals. In four instances more than one person participated in an interview. Thirteen of the interviews were face-to-face,

and three were conducted by telephone. The interview followed a predetermined interview schedule with the potential for exploration of topics in detail if the circumstances so determined. This slowed the conduct of each interview, but allowed for the voices of the panel of experts to be expressed more directly. The same researcher conducted all interviews. After each interview the researcher took field notes, which were later used for developing illustrative scenarios. Interviewees confirmed the model by the practices they are involved with in the industry, as well as with the exemplifying issues they have presented. No changes were requested for the developed exploratory model. However, issues involved in dealing with services such as non-measurability, non-standardability and human related factors were raised. Interviewees reported that model could be useful and meaningful for their practices. Descriptions involved cases they have had managed before. These descriptions had been pooled in order to develop illustrative scenarios for better conveying the exploratory model and related propositions developed in Chapter 3.2. These illustrative scenarios are available below:

Firm ***A*** has established supplier relations with firms ***B***, and ***C***. Proposition 1 is illustrated by the situation where Firm ***A*** is the supplier and Firm ***B*** is the buyer. Proposition 2 is illustrated by the situation where Firm ***A*** is the supplier and Firm ***C*** is the buyer. These scenarios are built upon insights obtained from experts with supplier relations positions in various firms of the Turkish Automotive Industry.

Firm A: ***A*** is a mid-sized company located in Turkey. Products of ***A*** are tailor made within a range of technical specs obtained during order processing. This customization opportunity that ***A*** offers to its buyers can only be utilized via technical help delivered by specially trained personnel that guides buyers' order arrangements. ***A*** also offers special packaging if the buyer wishes normal packages not to be used for any reason (color, size, lot, shape, etc.). Rarely, if an opportunity to be involved in new product design arises, ***A*** builds a team of its own and conducts feasibility studies for the new technology or improved productivity investments to be undertaken, and then delivers a collaborative offer to the buyer. ***A***'s technical personnel updates buyer at least twice a year by the seminars conducted, and they are accessible by cellular phone during work hours.

Firm B: Firm B is a buyer located in Europe. Each transaction between ***A*** and ***B*** requires a Letter of Credit to be processed, and some extra special logistics' arrangements. ***A*** fulfills all technical requirements of ***B***, and is very competitive as a supplier in terms of price, on-time delivery, and defect size. ***B*** has a well-established R&D department, and does not require any technical assistance from ***A***. ***A*** has specially trained personnel with good language skills to take care of relations with ***B***, however logistics arrangements and payment processing are major concerns that cannot be smoothly operationalized in half of the encounters. Time zone difference sometimes creates problems as well; ***B*** experiences difficulties in contacting ***A*** during its own work hours. Apart from production technologies, ***B*** also prefers state-of-the-art technology to be used by employers (i.e., Blackberry and palm device). Moreover, it uses interior designers for creating to most efficient and influential office space. ***B***'s personnel receive regular trainings for both technical and non-technical job skills, where the range can extend to topics such as pleasant communication, smart appearance and empathic meditation. Moreover, checks and cash rewards for extracurricular activities are available to personnel that perform satisfactorily. Though the performance criteria imposed involve response to job related inquiries in less than 2 hours, same level of performance at every inquiry, and strict follow up of the keep your promise rule. Lastly, all stakeholders of ***B*** are required to participate in corporate social responsibility projects, where individuals get to meet each other in person.

Firm C: Firm C is a buyer located in Turkey. ***C*** is a small-scale company, which relies mostly on raw materials it gets from ***A*** for its production to continue smoothly. To enhance productive measures, it benefits from the suggestions of ***A***'s technical personnel, and usually follows their guidance. ***C*** does not have any computerized systems of its own for planning material needs. The Information Technology policy of ***C*** follows the use of the old technology for office needs as well; new technology is only adopted when the one used becomes unavailable. Computers and servers crash often, e-mail response times can extend to a week. ***A***'s personnel follows ***C***'s seasonality, and probable needs, and gets prepared for orders of such nature before ***C*** calls for an order. ***C***'s payments usually require follow-up, but are not later than a week yet in 5 years. ***C***'s buyer has certain criteria for ***C***'s raw material supplier, and ***A*** is among the industry leaders of such nature. On the other hand, often exhausted

personnel of ***C*** experiences high turnover rates, and majority of the personnel misses the adequate technical trainings. No non-technical trainings are delivered at ***C***. As a result, ***C***'s employers often learn by experience, assignment are rarely completed without flows on time, especially if less experiences staff is given responsibility. Moreover, reports might carry mistakes. Employees burnt out by the work load have recently built the habit of not answering phones on purpose, as they are busy with other tasks.

As the scenarios above indicate, the domain examined involves non-numerical symbolic interpretations. These types of interactions are usually handled by computerized systems. Among these computerized systems (Table 3.3.2), expert system is found to be the best serving methodology for providing an attempt to answer the third research question. There is a need for an application that would transfer supplier's human expertise in order to advise and explain complex decisions. These decisions are often undertaken by the use of unstructured rules where symbolic manipulation of factual and procedural knowledge is employed. The aim here is to design service offering levels for various buyers in order to generate superior perceived buyer at each buyer but keeping costs at minimum. These reasons have mainly influence the decision to undertake an expert system approach. Moreover, rather than pursuing a single uniform approach for all buyers, a customized approach for each buyer's service-level expectations depending on the comparison of operational mediums, would both enable optimization of supplier's service-level costs, and ensure perceived buyer value generation to be of superior. Therefore, next chapter is dedicated to reviewing expert systems.

Table 3.3.2. Attributes of computerized systems

Dimension	Transactions Processing Systems (TPS)	Management Information Systems (MIS)	Decision Support Systems (DSS)	Expert Systems (ES)	Executive Information Systems (EIS)	Neural Computing	Knowledge Management Systems (KMS)
Applications	Payroll, inventory, record keeping, production and sales information	Production control, sales forecasting, monitoring	Long-range strategic planning, complex integrated problem areas	Diagnosis strategic planning, internal control planning, strategies.	Support to top management decisions, environmental scanning	Complex, repetitive decisions; diagnosis, control and investment	Complex decisions in a changing environment

Table 3.3.2. Attributes of computerized systems (continues)

Dimension	Transactions Processing Systems (TPS)	Management Information Systems (MIS)	Decision Support Systems (DSS)	Expert Systems (ES)	Executive Information Systems (EIS)	Neural Computing	Knowledge Management Systems (KMS)
Focus	Data transactions	Information	Decisions, flexibility, user friendliness	Inferencing, transfer of expertise	Tracking, control, drill-down	Pattern recognition	Reusability of best practices
Database	Unique to each application, batch update	Interactive access by programmers	Database management systems, interactive access, factual knowledge	Procedural and factual knowledge; knowledge base (facts, rules)	External (online) and corporate enterprise-side access (to all databases)	Historical cases, provide learning	Organizational knowledge repository
Decision Capabilities	No decisions	Structured routine problems using conventional management science tools	Semi structured problems, integrated management science models, blend of judgment and modeling	System makes complex decisions, unstructured; use of rules (heuristics)	Only when combined with a DSS	Mainly predictions based on historical cases	Complex, including enterprise level
Manipulation	Numerical	Numerical	Numerical	Symbolic	Numeric (mainly), some symbolic	Numeric needs preprocessing	Numeric, qualitative, symbolic
Highest Organizational Level Served	Sub managerial, low-level management	Middle management	Analysts and managers	Managers and specialists	Senior executives (only)	Specialists and managers	Managers and specialists
Impetus	Expediency	Expediency	Effectiveness	Effectiveness and expediency	Timeliness	Expediency	Effectiveness and expediency

Source: (Turban and Aronson, 2001, p.23)

3.4 Summary

Suppliers in the automotive industry develop their activity under constantly changing service level conditions, since buyers continuously demand more reduction in costs, as well as improvement in quality and service (Benavides and Prado, 2002). To achieve this, suppliers set out special programs to reduce costs and improve the organization and technology. With a special boomerang effect, these programs eventually yield to higher expectations from suppliers. As examples of this, frequent deliveries in small quantities, constant modifications in product lines, quality assurance supported by the supplier, and the introduction of the decision support systems in the interaction between customer and supplier can be mentioned (Benavides and Prado, 2002).

Aiming to discover the anatomy of superior perceived buyer value creation in the supplier-buyer interaction upon supplier's provision of services, this research endeavor has proposed an explanatory model in this chapter. Explanatory model had been developed with an analogy from Snell's Law. It has been found meaningful and useful by the panel of experts conducted. With these discussions, a thorough investigation had been provided to the second research question that drives this research endeavor. In a further attempt to assist a supplier in what to do in order to create superior perceived buyer value, it was concluded that an expert system should be built in line with the explanatory model. The elusive and abstract nature of services, and the tacit knowledge human experts reviewed in their decisions on the provision of services led to the use of heuristics. Here, expert systems provide opportunities of working with knowledge instead of data, as well as using symbolic reasoning. Besides, there is also an emerging call in the literature for the importance of services focused research, where use of expert systems for improved approaches to be developed is suggested (Metaxiotis, 2005). Therefore, next chapter is devoted to expert systems.

4. EXPERT SYSTEMS (ES)

Expert System (ES) applications are widely used for diagnosis strategic planning, internal control planning, maintenance strategies, with a focus on inference, as well as transfer of expertise from a human expert. Procedural and factual knowledge is utilized in an ES via a knowledge base containing facts and rules. Rules integrated by symbolic manipulation enable performing unstructured complex decision capabilities. ES delivers advice and explanations to the users, who are top managers, specialists, non-experts, human being in the expertation process or experts themselves. Effectiveness and expediency improvements are the major promises of impetus (Turban, 1990).

Attention is devoted to the third research question starting from this chapter, which discusses the history and theory, main elements, differences from conventional computer programs, application areas, benefits, and development process of ES. The first section of the chapter provides a detailed overview of the ES history and theory. Then, main elements of an ES are covered. This is followed by a outlining the differences between ES and conventional computer programs. Next, application areas of ES are examined. Particularly, ES literature is reviewed for production and operations management and service management in subsequent two sections. The penultimate section covers the benefits of ES. Finally, the ES development process is presented.

4.1 History and Theory

Expert system is defined as a computer program that draws upon the knowledge of human experts captured in a knowledgeable base to solve problems that normally require human expertise (Benavides and Prado, 2002; Chao and Horng, 2003; Jayaraman and Srivastava, 1996; Shaluf and Ahamadun, 2006; Welbank, 1983). By

providing a way to store human knowledge, expertise, and experience in computers, expert systems are designed either to take the place of human experts, or to aid them.

Expert systems have been developed by artificial intelligence researchers while building a "thinking" computer. Initially, reasoning was seen basically as problem solving (Newell and Simon, 1972). Also known as General Problem Solver (GPS), this approach underestimated the role of specific knowledge in reasoning. Having realized the opportunities, research had been developed in more specific knowledge areas such as medicine. "*With this development the notion of an expert system was born: a computerized system that has knowledge and can reason about a specific and limited domain* (Hoog and Wielinga, 2003)". Some earliest examples of these systems are discussed below.

DENDRAL used domain-specific knowledge as an early example of expert system (Buchanan et al., 1969). On the basis of the chemical composition of the molecule, DENDRAL identified the structure of organic molecules, and measured mass spectogram. Using a generate-and-test method for creating hypotheses about possible structures, hypothetical mass spectrogram was generated and compared to the experimental spectrogram. The solution to the structure identification problem was represented by the best matching experiential spectrogram (Hoog and Wielinga, 2003).

Being the first applications of Artificial Intelligence in real world domain, DENDRAL is viewed as a precursor of the expert system paradigm. Expert system paradigm typically chooses realistic problem domains that require considerable expert knowledge when handled by humans. In addition, expert systems use rules as a way of representing domain knowledge. Some rule-based systems, such as PLANNER (Hewitt, 1969), are considered as problem solving knowledge rather than representations of domain knowledge. However, situation-action rules of DENDRAL represented knowledge that corresponds to a suggested action upon detection of a particular situation. Moreover, expert system paradigm often uses human domain experts to acquire the rules. Construction of knowledge base demands domain human experts with limited technical expertise of artificial intelligence, therefore needs considerable effort (Buchanan et al., 1970). In addition, the generate-

and-test method of DENDRAL employed a task-specific method for a particular task, which is another characteristic of the expert system paradigm.

The frontier prototypical example of a large family of expert systems developed in the 80's was *MYCIN*, which advised about treatment of infectious diseases (Buchanan and Shortliffe, 1985; Shortliffe, 1976a). Similar to DENDRAL, MYCIN also employs roles for representing its medical knowledge. Common to many early experts system, MYCIN's rules reason in a backward manner and start with the goal to derive the identity of the organism causing the disease. Besides, MYCIN also exploits certainty factors regarding the reliability of the inference conducted by applying the rules. Another reflection of MYCIN from the expert system paradigm lies in the explanation of the reasoning process, where chain of rules that it has used to come to a conclusion are provided to the user in an easily understandable format (Hoog and Wielinga, 2003).

Schlumberger developed the *Dipmeter Advisor* for internal use in oil well drilling for analyzing encountered geological formations. hydrocarbon reservoir structures were defined, and draining methods were designed according to this information since system was better than humans in reading of dipmeter logs (Hoog and Wielinga, 2003).

Coopers & Lybrand US developed *ExperTAX* to help the evaluation of the application of new US tax laws to their clients. Incorporating the knowledge of forty top partners of the firm, ExperTAX replaced a written questionnaire, which was approximately two hundred pages long and needed to be analyzed by one the senior tax experts. Audit and tax staff also used ExperTAX to draw conclusions in the tax planning and tax accrual processes (Hoog and Wielinga, 2003).

From these early systems, steadily emerged a leading architecture of expert systems, which still echoed the old dream of a kind of general problem solver. Based on a separation of domain knowledge on general reasoning knowledge, an "inference engine" was employed. The inference engine often relied on either one of the common two artificial intelligence search techniques: backward chaining or forward chaining. "IF … THEN …" type rules were used to represent majority of the domain knowledge. Backward chaining tried to prove the consequent by gathering evidence

for the antecedent (the IF part), while forward chaining executed all rules for which the antecedent (the THEN part) is true. This general architecture provided the basis for the development of "Expert System Shells", which embody the domain independent components such as the rule representation, inference engine and explanation system. For example, EMYCIN ("Empty MYCIN") is an expert system shell derived from MYCIN (Van Melle, 1979). For a human expert to define rules in a simple way, "rule editor" interfaces was provided with the hope to solve the knowledge acquisition bottleneck problem by having the expert create the domain knowledge base without the intervention of the knowledge engineer.

Development of early speech recognition programs, such as HEARSAY I (Reddy et al., 1973), provided an alternative architecture known as blackboards. The interpretation of an utterance could change when the next utterance came along in speech recognition; therefore deferring inferences until more evidence became a concern. Since neither backward nor forward chaining granted a remedy, blackboards that provide places for hypotheses to be temporarily "parked", independent of the level of abstraction, until more incoming evidence permitted a confirmation or rejection, proved to be useful.

Being mainly laboratory prototypes, most of the early expert systems, never or only briefly, made it into full operational use in a commercial setting. Digital had been the first one to develop and use an expert system for commercial purposes. Their system was named XCON, and it supported the configuration of complex computer equipment. XCON had been one of the most publicized expert systems of the 80's (Mumford and Macdonald, 1989). Indeed XCON had been initiated as an academic expert system, known as R1 (McDermott, 1982). R1's rule production interpreter architecture had an engine, which used a forward reasoning strategy using a "working memory" to store dynamically derived data. The rule that the content of the working memory matched with had been launched, whenever multiple rules seized applicable then a selection was undertaken by a resolution process. In addition to domain rules, R1 –and later XCON- also contained "task rules", which represent knowledge about how to perform the configuration task. XCON had a big impact on the organization of Digital. It did not only take over the configuration of orders from human experts, but it also delivered higher quality configurations than humans.

Eventually, it promoted a strategic change in Digital's delivering process. Previously, configured systems were assembled and tested in special factories prior to shipment to the buyer. With XCON's employment, such testing became obsolete saving Digital several millions of dollars. Motivated by the success of XCON, Digital later decided to develop an expert system to support the sales persons. XSEL was developed to assist sales staff in assembling an optimal and consistent order for a client. Even though the system was technically sound, its introduction and acceptance by the users proved less successful than that of XCON, particularly in Europe. It is discussed that There was a mismatch between users, organization and the technical realization (Metselaar, 2000).

Some other examples of expert systems developed during the 80's also involve DELTA/CATS (Bonnisone and Johnson, 1983), which was developed by General Electric to assist railroad personnel in the maintenance of diesel-electric locomotives, as well AUDITOR (Dugan and Chandler, 1985) and DECMAK (Bohanek et al., 1983), which were used for auditing and decision making, respectively.

4.2 The Main Elements of Expert Systems

ES consists of three main components, which include the *knowledge base*, the *inference engine* and the *user interface* (Figure 4.2.1) (Metaxiotis, 2005; Metaxiotis et al., 2002). As the core of the ES, *knowledge base* hold knowledge – in the form of facts, heuristics, and relationships that are collected from human experts through various knowledge acquisition methods – needed for solving a particular problem (Metaxiotis et al., 2003). Representation of knowledge can employ different techniques (e.g. semantic nets, frames), though most common approach is to use "If-Then" production rules (Badiru, 1992; Ignizio, 1991; Mital and Anand, 1994).

Inference engine used in consultation sessions, scrutinize and handle knowledge base and determine the order of inferences granted by the aid of various inference methods, even under the conditions of uncertainty (Badiru, 1992; Ignizio, 1991; Metaxiotis et al., 2002; Mital and Anand, 1994).

User interacts with ES by the *user interface* which commonly involves screen displays, consultation/advice dialogues and explanation components. Moreover, for

purposes of communications with external programs like databases and spreadsheets, as *external interfaces*, can be integrated (Metaxiotis, 2004).

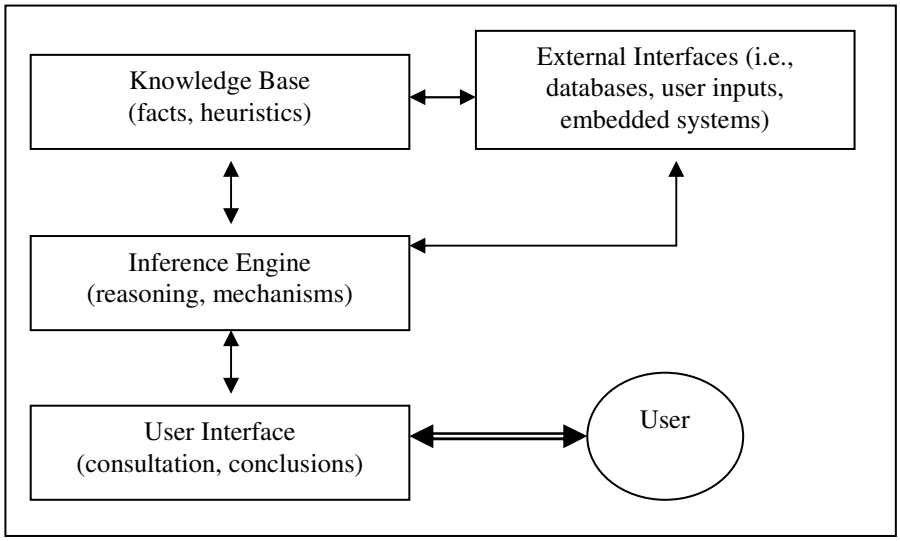

Figure 4.2.1. Expert system architecture (Metaxiotis, 2005, p.235)

4.3 Expert Systems and Conventional Computer Programs

Understanding and appreciating the differences between conventional computer programs and expert systems is imperative. The most basic difference between the two is that conventional programs process data, while expert systems process knowledge. This basic difference influences both the nature of the processing technique used and the results obtained. The general differences between expert systems and conventional programs are characterized in Table 4.3.1 (Durkin, 1990).

Table 4.3.1. Expert system versus conventional programs

	Conventional Programs	**Expert Systems**
Data	Numeric	Symbolic
Processing data	Algorithmic	Heuristic
Characteristic of information	Precise and complete	Allow for uncertain and/or incomplete
Interface	Command	Natural dialogue and explanations
Steps available to user	Only final solution provided	Recommendation with explanation
Conclusion	Optimal solution	Acceptable solution

Source: (Durkin, 1990, p.173)

4.4 Application Areas of Expert Systems

The first expert system was developed in 1965 by Edward Feigenbaum and Joshua Lederberg of Stanford University in California, U.S. DENDRAL, as their expert system was later known, was designed to analyze chemical compounds (Zwass, 2007). Since then the spectrum of applications of expert systems technology to industrial and commercial problems is so wide as to defy easy characterization (Durkin, 1993). Available in areas of knowledge work, applications vary from helping salespersons selling modular factory-built homes to helping NASA plan the maintenance of a space shuttle in preparation for its next flight. There are different classification schemes adapted in the literature. Among these, cognitive studies of human problem-solving have revealed the different strategies humans use to approach to different problems (Hayes-Roth et al., 1983). By categorizing these commonly used reasoning methods, problem-solving paradigms are uncovered. Expert system designers characterize the different styles of reasoning into various paradigms (Durkin, 1990), where humans collect information about each problem differently and process this knowledge with the domain knowledge, by using different methods (Table 4.4.1).

Table 4.4.1. Types of problems solved by expert systems

Paradigm	**Description**
Control	Interpreting, prediction, repairing and monitoring system behaviors
Design	Configuring objects under constraint
Diagnosis	Inferring system malfunctions from observables
Instruction	Diagnosing, debugging and repairing student behavior
Interpretations	Inferring situation description from data
Monitoring	Comparing observations to plan vulnerabilities
Planning	Designing actions
Prediction	Inferring likely consequences of given situations
Prescription	Recommending solution to System malfunction
Selection	Identifying best choice from a list of possibilities

Source: (Durkin, 1990, p.175)

Alternatively, Feigenbaum et al. (1993) argue that ES applications tend to cluster into seven major classes:

1. Diagnosis and Troubleshooting of Devices and Systems of All Kinds

Systems which infer faults and recommend corrective actions for a malfunctioning appliance or procedure form this class. Though ES technology was first applied to medical diagnosis (Shortliffe, 1976b), that of engineered systems quickly exceeded medical diagnosis. Most commonly, the diagnostic problem is stated as: "given the evidence presenting itself, what is the underlying problem/reason/cause?"

2. Planning and Scheduling

Taking into account personnel, material and other constraints, systems of this class analyze a set of one or more potentially complex and interacting goals in order to determine a set of actions to achieve those goals, and/or provide a detailed temporal ordering of those actions. Presenting high commercial value, some examples are (1) airline scheduling of flights, personnel, and gates; (2) manufacturing job-shop scheduling; and/or (3) manufacturing process planning.

3. Configuration of Manufactured Objects from Subassemblies

The most important expert system application is the configuration, whereby a solution to a problem is synthesized from a given set of elements related by a set of constraints. Computer companies initiated configuration applications as a means of facilitating the production of semi-custom minicomputers (McDermott, 1981). The many industries that have made use of the technique vary from modular home building and manufacturing to complex engineering design and manufacturing problems.

4. Financial Decision Making

The financial services industry is also utilizing expert system techniques via advisory programs that assist bankers in determining whether to make loans to businesses and individuals. In addition, insurance companies use expert systems for assessing the risk presented by the customer and determining a price for the policy.

5. Knowledge Publishing

As a relatively new, but potentially explosive area, in knowledge publishing knowledge that is relevant to the user's problem, in the context of the user's problem is delivered. An advisor which counsels a user on appropriate grammatical usage in a text, and a tax advisor that accompanies a tax preparation program and advises the user on tax strategy, tactics, and individual tax policy are the most popular ones.

6. Process Monitoring and Control

Aiming to notice anomalies, predict trends, and control for both optimality and failure correction, expert systems in this class analyze real-time data from physical devices. These are widely used in the steel making and oil refining industries.

7. Design and Manufacturing

Ranging from high-level conceptual design of abstract entities all the way to factory floor configuration of manufacturing processes, this class of expert systems assist in the design of physical devices and processes.

On another note, Jayaraman et al. (1996) discuss that in order to provide some classification scheme and to enable development of the ES, one should first be able to identify the decision areas for which the system is being developed (Jayaraman and Srivastava, 1996).

Table 4.4.2 lists the eight different expert decision areas. This research endeavor, for instance, attempts primarily to *consulting* decision area, in addition to *diagnosing* and *monitoring* decision areas.

Table 4.4.2. Expert decision areas

Expert decision area	**Expert tasks**
Consulting (CON)	recommendation of certain actions or behavior given the set of constraints and circumstances (Mertens and Allgeyer, 1983)
Designing (DES)	designing specifications for objects that satisfy a given set of constraints (Stefik et al., 1986)

Table 4.4.2. Expert decision areas (continues)

Expert decision area	**Expert tasks**
Diagnosing (DIA)	analyzing and verifying whether the system is functioning in its proper state (Stefik et al., 1986)
Interpreting (INT)	confirming the reliability of data with regard to its comprehensibility (Stefik et al., 1986)
Monitoring (MON)	continuous interpretation of signals and the setting-off of alarms as needed (Stefik et al., 1986)
Planning (PLA)	creating programmes of action that are to be carried out to achieve a goal (Stefik et al., 1986)
Predicting (PRD)	forecasting some future event (Stefik et al., 1986)
Teaching (TEA)	tutoring and diffusion of knowledge (Mertens and Allgeyer, 1983)

Source: (Jayaraman and Srivastava, 1996, p.29)

As Rao et al. (2005) state, since their introduction, ES applications have rapidly increased to business problems (Wagner et al., 2001) where businesses, decision-making in businesses, and accounting management of corporations have been the frontiers of benefits (Foltin and Garceau, 1996; Qureshi et al., 1998; Wagner et al., 2002). These numerous business and decision-making applications have been categorized (Blanning, 1984; Coakes et al., 1997; Eom, 1996; Eom et al., 1993; Santhanam and Elam, 1998; Wong and Monaco, 1995a; Wong and Monaco, 1995b), where conclusions indicate majority of applications are present in production/operations management area and minority in human resources area (Wong and Monaco, 1995b). Some other areas of applications include but are not limited to performance appraisal of employees (Ghosh and Kumaraswamy, 2002), performance measurement of advanced manufacturing technology projects (Ngai and Cheng, 2001), productivity measurement using the total productivity model (Sumanth and Dedeoglu, 1987), auditing and internal control assessment (Changchit and Holsapple, 2001; Foltin and Smith, 1994; Hornik and Bernadette, 1997; Qureshi et al., 1998).

Over the years, industrial interest has been sensibly dedicated by Digital Equipment, Texas Instruments, IBM, General Motors, Xerox, Hewlett-Packard, Carnegie Group, Intellicorp and many others (Metaxiotis and John, 2003). In addition, MIT, Stanford, Carnegie-Mellon, Rutgers, UMIST, NTUA and other universities continuously

engage in expert system technology and develop both practical and pure academic applications (Metaxiotis and John, 2003).

4.5 Expert Systems in Operations Management

By the mid-1960s, Experts Systems (ES) evolved as a branch of applied artificial intelligence. Transferring body of task-specific knowledge, which is accumulated over time by expertise, from human to computer has been the original drive. Once knowledge is present in a knowledge base, any user with access privileges would then be able to receive specific advice whenever needed, with inferences involved in reaching that advice. Similar to a human consultant, a system would then be able to present the logic inherited in an advice (Turban et al., 2004). Variety of problems that cannot be treated by means of more traditional and orthodox methods can be solved by the aid of powerful and flexible tools of ES. Therefore, wide spread uses of them in social and technological lives evolves, and such applications can be become critical especially in the process of decision support and problem solving (Liao, 2005).

Production and operations management (POM) have proved to be a promising area for ES application. Mertens and Kanet (Mertens and Kanet, 1986) provided a taxonomy for classification of ES in production management. However, since their paper did not provide a distinction between engineering (eg. manufacturing engineering, industrial engineering) and POM, and did not provide a complete listing of decision areas in POM, Jayaraman (Jayaraman and Srivastava, 1996) developed a different way of classifying the ES in POM on the level of applicability of the ES to the decision-making areas of POM. He proposed that decision making in POM should be categorized into two major areas: strategic and operational/ tactical (Figure 4.5.1).

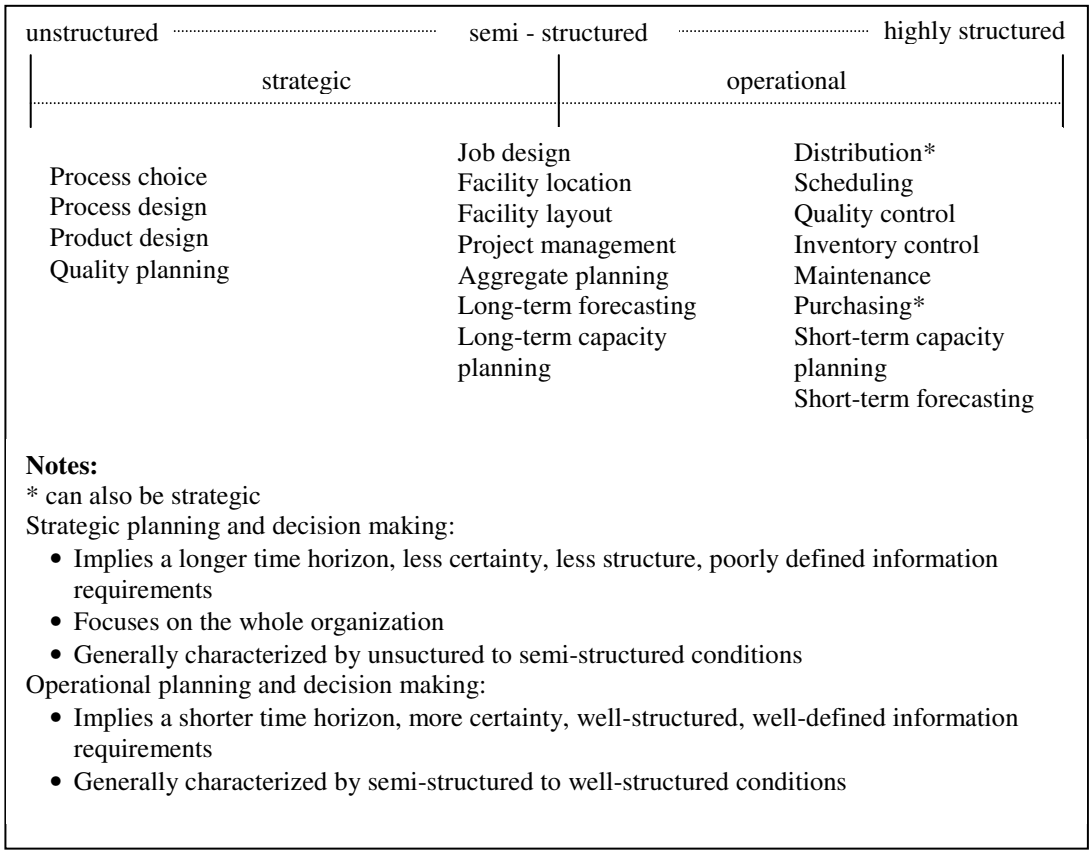

Figure 4.5.1. Decision making classification in POM (Jayaraman and Srivastava, 1996, p.33)

Accordingly, applications of ESs in the different decision areas of POM can be classified in capacity planning, facility location and design, facility layout, project management, aggregate planning, process choice/design, product design scheduling, quality management, inventory control, maintenance, forecasting, distribution, and purchasing categories (Kathawala and Allen, 1993; Metaxiotis et al., 2002; Palaniswami and Jenicke, 1992; Sousa et al., 1999; Wong et al., 1994). It is deduced that ES is utilized in various decision making steps of production and operations management field.

An expert system (ES) offers service companies a tool which can increase productivity, profitability and service quality (Tieperman et al., 1994). An ES provides a strategic competitive advantage to services management through its inherent benefits which:

- standardize services
- increase flexibility

- facilitate effective training
- induce continuous improvement
- minimize human inconsistencies.

A service company can utilize uniformity to capture the advantage of standardization, which controls employee discretion. Theodore Levitt (1972) describes discretion as "*the enemy of order, standardization, and quality*". An ES contributes to standardization of services, and increases efficiency and effectives. For example, employing an ES to take care of monotonous everyday tasks to increase effectiveness and reduce inconsistencies in provision of services. Moreover, efficiency increases since ES takes care of routine problems, allowing time for personnel to handle more specialized problems. In addition, the intangible and perishable nature of services creates uncertainty that demands subjective interpretation of information for reliable decisions. However, employee interpretations of policies, procedures and service quality tend to vary widely. An ES can communicate corporate guidelines precisely. On another note, the increased information processing speed of an ES provides a company the needed flexibility to customize services that improve customer relationship and cross-sell (Braun, 1990; Coats, 1988; Frank et al., 1988; Leonard-Barton and Sviokla, 1988; McCann and Gallagher, 1990; Shortliffe, 1976a).

In terms of training, ES has shifted the focus of training from the traditional, passive "What do you want the trainees to know?" to the active "What do you want the trainees to be able to do?" perspective (Kirrane and Kirrane, 1989). As training is quintessential for a service company, an ES reduces the time which a company's managers spend explaining procedures to transferees or new employees (Blackwell et al., 1990).

Motiwalla (1992) suggests several reasons as to why ES are ideally suited for service operations. First, ES are highly interactive programs, in which an end-user can demand a must-run explanation or clarification at any time while running an application. This makes ES an ideal technology for most service operations, as service consumers or clients play an active role, in terms of providing information and asking questions, during the facilitation of the service. This characteristic of ES is ideally suited for the simultaneous provision and consumption component of

service operations. Second, ES are much speedier in service delivery than most of their human counterparts, making them more suitable for services where speed and timeliness are critical to the provision of the service. Third, ES do not fatigue and hence can provide consistent and round-the-clock service. Finally, since there is a great degree of subjectivity and intangibility in service operations, it is essential that important decision-making tools such as ES be made use of in service operations. There is not only a great deal of subjectivity in the decision-making process of the service provider, but there is also an enormous amount of subjectivity and naivety on the part of the service consumer. Therefore ES employment remains important both for the service provider and the service consumer.

Buyers are becoming increasingly militant about the quality of products and services they purchase (Chase and Garvin, 1989; Davidow and Uttal, 1989; Denton, 1994; Garvin, 1987; Sherden, 1988). In this context, expert systems undertake a major role in aiding companies to improve their service quality (Eppinette and Inman, 1997). As A. Blanton Godfrey (1994) asserts "*Information systems become vital for gauging quality*." The use of experts systems in various service industries are detailed in numerous articles (Table 4.5.1). Even though the field is blooming, when compared with other fields of management, ES applications in services remain limited. In his seminal work, Metaxiotis (2005) reviews the ES literature of services management applications, and concludes that the field remains fertile and calls for emerging research to focus on the area.

Table 4.5.1. ES applications in service industries

Types of services industry	Literature
accounting and finance	(Baldwin-Morgan, 1994; Bobis and Bachand, 1993; Boritz and Wensley, 1992; Brown and Phillips, 1990; Butters and Eom, 1992; Chuleeporn and Clyde, 2004; Denna, 1994; England et al., 1989; Flesher, 1987; Foltin and Smith, 1994; Goldwater and Fogarty, 1993; Harrington and Twark, 1991; Jesse and Kristi, 2001; Laurie, 1999; Leonard, 1993; McDuffie et al., 1994; Muggridge and Lymer, 1993; Newquist, 1987; Oz et al., 1993; Philip et al., 1999; Phillips and Brown, 1991; Sangster, 1996; Shim and Rice, 1988; Simpson, 1994; Smith et al., 1991; Williams, 1993)
criminal justice system	(Copley, 1994)
health care	(Bobis and Bachand, 1993; Butters and Eom, 1992; Simpson, 1994)
ecology	(Kuzmin and Solovyov, 1993; Marc, 2002; Starfield et al., 1990)
retailing	(Achabal and McIntyre, 1987; Curry, 1989; Kriss and Bovee, 1989)
real estate	(Linda Ellis et al., 1997; Moore, 1992)
construction	(Al-Hussein et al., 2006; Lopez and Balderrama, 1993; Lowe et al., 1993; Qiping et al., 2001; Yang, 2004; Yun-Kung, 1999)
banking	(Curry and Moutinho, 1993; Davies et al., 1995; Doherty and Pond, 1995; Forsey and Finlay, 1989; Nielson et al., 1993)
training	(Cascante et al., 2002; Dankbaar, 1996; Kaula, 1993; Keith and Maharshi, 1997; Lucila Perez et al., 2002; Nitaya et al., 2000)
transportation	(Kodali, 1992)
communication	(Phil, 1998)

4.6 Benefits of Expert Systems

Potential benefits of ES involves improved and/or consistent decision-making, reduced design and/or decision-making time, improved training, operational cost savings, better utilization of available expert(s), improved product and/or service levels, and capability to capture rare and/or dispersed knowledge (Liang, 1988).

Englard et al. (1989) indicate that “expert systems are artificial intelligence systems that emulate human thinking processes in problem-solving situations”, and their goal is “to arrive at the same results that a specific human mental process would produce”. In this regard, capability of ES to conclude a recommendation or decision differentiates it from traditional decision support system (DSS) that can only output information that needs to be utilized in arriving at a conclusion, recommendation or

decision. From a process standpoint, this implies that a traditional DSS has data as its input and information as its output, but an ES has knowledge as its input and decision or conclusion as its output, placing ES a step beyond a DSS. Knowledge on handling various services that are known for their perishability, inconsistency, simultaneous production and consumption, and requirement of personal interaction, could hence be captured by the virtue of ES and some classification can be represented for some organizational outputs. The ability of ES to come to a conclusion, and to come to the same conclusion given the same input time and time again, is what makes them so applicable to be utilized for services' factors when compared to human experts who are known to actually limit standardization and quality control approaches to certain extend (Levitt, 1972). In addition, ability to include uncertain or incomplete information enables ES to better imitate the human decision-making process in a service situation (Epinette et al., 1997).

Several of the potential benefits to an organization from developing and using an ES are listed below (Jayaraman and Srivastava, 1996; Metaxiotis et al., 2002; Stone, 1990):

One problem organizations are faced with is the loss of key personnel due to retirement, death, or new employment opportunities. Once an expert's knowledge and heuristics are captured in an ES, these are stored and cannot be lost. Expertise becomes available on any suitable computer hardware, thus the system disseminates expertise more widely. The costs of employing a human expert either through training or hiring are generally much greater than developing an ES. Cost per user of providing expertise is hence lowered. Further, a clone of the expert system can be made using a straightforward copy command. Again, this is generally much easier and less expensive than hiring or developing new human experts. Moreover, expert systems can be used in situations that would be hazardous to a human.

An ES can combine the knowledge of several experts in the domain area, thus making the expert system superior when compared to individual human experts with multiple expertise. In addition, an ES, unlike its human counterpart, does not forget any knowledge or change its advice based upon its mood or health, making ES advices consistent. Steady, unemotional and complete response at all times is granted as ES don't suffer from stress or fatigue. An additional advantage of an ES is that it

can be put to work on the common cases requiring expert advice, freeing the human expert to deal with the unusual and demanding cases. ES is not subject to human variability, therefore provides increased reliability. Although an ES can only solve problems which human experts can solve within a reasonable time limit, ES can provide a better analysis of the problem by processing more data and directly considering any uncertainty.

Another benefit is the capability to train non-experts by explained reasoning behind every conclusion. Through these explanations, the human expert may gain additional insights concerning the process for which the system is used. ES can explicitly explain in detail to all interested parties, at all times, the reasoning that leads to a conclusion. This in turn, increases confidence in the decision, and a human expert would be unlikely to have the time, or the patience, to act similarly. Moreover, the ability to test sample scenarios and provide detailed reasoning for decisions makes the ES a useful tool for tutoring, especially in specialist domains. In addition, ES can be used to access data from a database relative to some problem solution strategy developed by the system, therefore can initiate an intelligent database. Besides, explicating expert knowledge becomes possible since the knowledge acquired from human experts is put in an explicit form for entry to knowledge base, in return enabling examination for correctness, consistency and completeness.

4.7 Limitations of Expert Systems

Despite its benefits, expert systems have certain limitations (Pigford and Baur, 1990). Though, these limitations are not very likely to yield to problems when they are recognized and accounted for (Kathawala et al., 1993).

First, expert systems are not competent to directly acquire knowledge. A knowledge engineer must acquire the knowledge and put it in a suitable format for the ES. Second, ES cannot refine its own knowledge base. Knowledge engineer should externally refine knowledge in terms of combinations of rules with the same conclusion or elimination of redundant or contradictory rules. Third, knowledge with mixed representation can not be dealt with by the expert systems. Forth, ES cannot learn from experience like its human counters. Fifth, expert systems don’t posses

what human experts refer to as the common sense. Finally, ES development process s usually expensive and time-consuming.

4.8 Development Process of Expert Systems

The process of building an ES is composed of *problem selection*, *knowledge representation*, *knowledge acquisition*, *knowledge engineering*, *knowledge testing and evaluation* (Jayaraman and Srivastava, 1996; Metaxiotis et al., 2002).

Regarding *problem selection,* Pope (1984) defines key areas that represent suitable problem domain with the following characteristics:

- Problem domain should be identifiable with certain limitations.
- An expert should exist and should be willing to co-operate and articulate.
- As ES is not capable of solving problems that cannot be solved by humans, ES should only be developed only for the problems that can be solved by human experts.
- Skills of human expert should be transferable to a computer program.

Concerning *knowledge representation*, knowledge that is contained within an ES should include:

- A priori knowledge, which contains facts and rules that are known about a specific domain before any contact or dialogue with the ES has occurred.
- Inferred knowledge, which contains facts and the rules concerning a specific case which are derived during or at the end of a consultation or interaction with the ES.

Following four properties should be present in a good system for the representation of knowledge in a particular domain:

- Representational adequacy, which is the ability to represent all kinds of knowledge that are essential a particular domain.
- Inferential adequacy, which is the ability to manipulate the structures in a way so as to derive new structures corresponding to novel knowledge surmised from the former.

- Inferential efficiency, which is the ability to incorporate additional information that can be employed to address the attention of the inferential mechanisms to feasible courses.
- Acquisitional efficiency, which is the ability to acquire novel information easily.

The *knowledge acquisition* involves transfer and transformation of problem-solving expertise from certain knowledge sources to a program. Also known as the expert system development bottleneck, this process often extends to long periods in dealing and interfacing with domain experts. Two commonly employed approaches in knowledge acquisition include acquiring knowledge directly from experts and rule induction, which is the acquisition via historical records.

Knowledge engineering represents the task of identifying adequate applications of ES and performing the process of development and implementation. Lastly, *knowledge testing and evaluation* contains a meticulous analysis and testing of the knowledge base and inference structure. Once the ES's scope of reasoning has been stabilized, the revisions should conclude a convergence towards an "ideal" ES.

Metaxiotis (2005) states that, successful ES development demands well-planned course of activities. It is important that a systematic approach is adopted from the identification of the problem domain, through the construction of the knowledge base and eventually to the implementation and validation of the system (Chandler and Liang, 1990).

Concerning the implementation of expert systems, there are mainly two groups of development tools (Baker, 1988; Huntington, 1985; Jackson, 1998): (1) Making use of high level programming languages (i.e., C++, PROLOG, LISP, etc.). Though use of these languages demand high degree of expertise and skill, a system designer using such might possess freedom in choice of knowledge representation techniques and control strategies (Metaxiotis et al., 2002). (2) Utilizing expert system shells (i.e., Nexpert Object, XpertRule, KnowledgePro, CLIPS, ReSolver, EXSYS, VP-Expert, ACQUIRE, etc.). Flexibility of artificial intelligence languages blended with cost effectiveness lead to general development facilities in expert shells (Metaxiotis et al., 2002). Following sections are dedicated to reviewing the particular phases of

the development process in order to define a systematic approach for this specific research endeavor.

This research utilizes an expert system shell, namely EXSYS Corvid, which is known to be amongst the most commonly used expert system shells (Darlington, 2000). In this context, together with the literature visited in this chapter, the development procedure will be based on the structure proposed by Turban (2001). Accordingly, ES development can be described in six phases (Turban and Aronson, 2001). These are (Figure 4.8.1):

- Project initialization
- System analysis and design
- Rapid prototyping
- System development
- Implementation
- Post-implementation

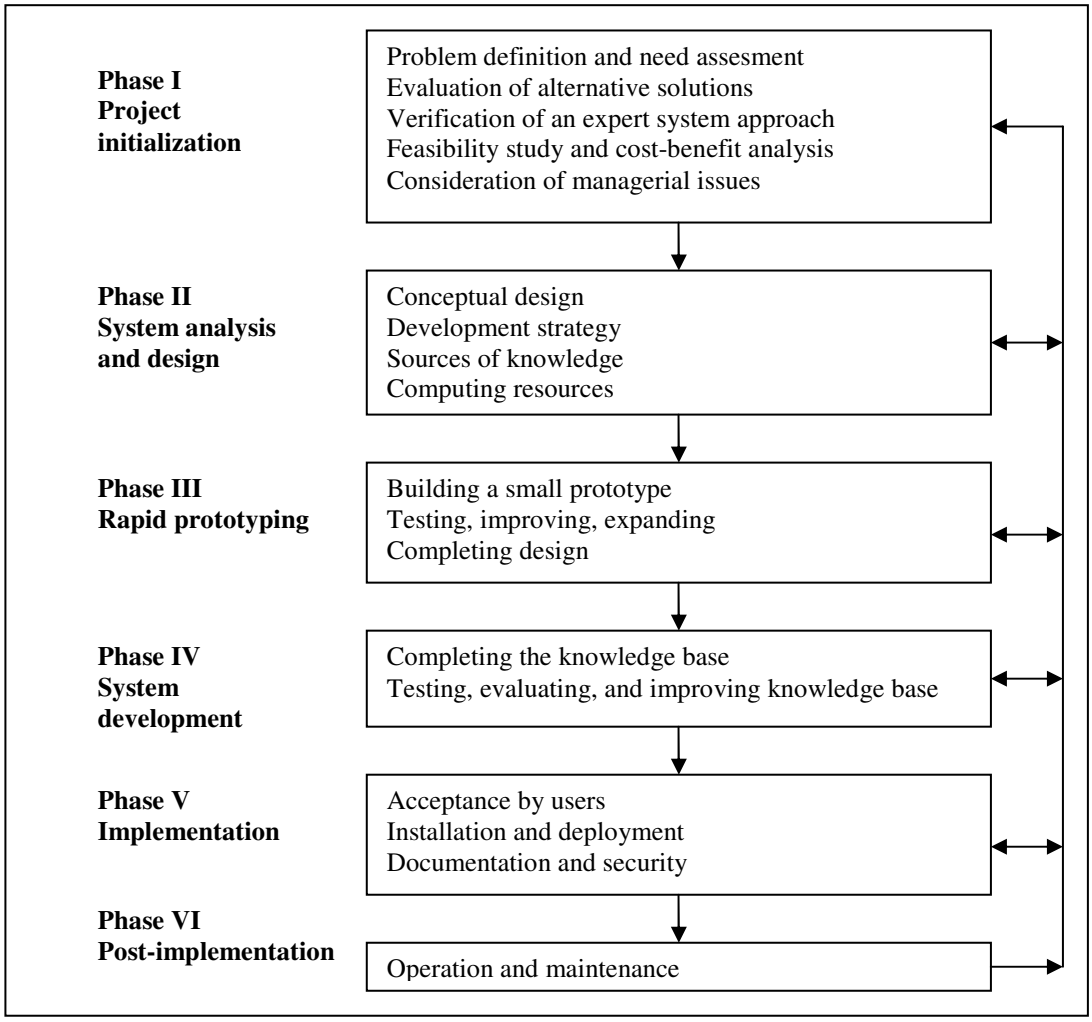

Figure 4.8.1. Schematic view of the ES development life cycle (Turban and Aronson, 2001, p.554)

1. Project Initialization

Launching an ES project can be tricky, and deciding that ES is a feasible approach to solving a particular problem is not trivial. Numerous factors must be taken into account, and countless ES projects fail because of poor problem selection. There are methodologies and checklists for determining the fit between a problem and the ES approach (Awad, 1996; Hartman, 1993; Medsker and Liebowitz, 1994; Prerau, 1990). "*The main factors are that the problem must have a sufficiently narrow domain and that some aspects of the problem must be qualitative, so that conventional computing approaches do not apply"* (Turban and Aronson, 2001). The

major tasks involved with project initialization, which are interrelated and do not necessarily follow a sequence, are listed below:

Problem definition and need assessment

Problem definition to be considered accurate, basic questions should be provided with an answer, e.g., what exactly is the problem; what are the real needs? Supporting information together with a need or problem statement could be used for this purpose. Problem definition is also related with need assessment and cost-benefit analysis.

Evaluation of alternative solutions

Alternative solutions to the problem should be revised before initiating a major ES development. Some alternatives that could be employed include use of experts, provision of education and training in class format, packaging the related knowledge into documents, developing conventional software, and/or purchasing knowledge from consultants.

Verification of an expert system approach

Problem fit with ES approach should be verified (Turban and Aronson, 2001; Waterman, 1985) where a three component study is possible for testing requirements, justification, appropriateness (Table 4.8.1).

Table 4.8.1. Elements of ES verification study

Requirements for ES development (fit with all elements should be seek)	The task does not require common sense The task requires only cognitive, not physical, skills There is at least one genuine expert who is willing to cooperate Experts involved can articulate their methods and problem solving Experts involved can agree on the knowledge and the solution approach to the problem The task is not too difficult The task is well understood and is defined clearly The task definition is fairly stable Conventional computer solution techniques are not satisfactory Incorrect or non-optimal results generated by the ES can be tolerated Data and cases are available The task's vocabulary has no more than a few hundred concepts.
Justification for ES development (fit with either one of the elements should be seek)	The solution to the problem has a high payoff The ES can preserve scarce human expertise so that it will not be lost Expertise is needed in many locations Expertise is needed in hostile or hazardous environments The expertise improves performance or quality The system can be used for training The ES solution can be derived faster than one provided by a human The ES is more consistent or accurate than a human.
Appropriateness of ES (fit with all elements should be seek)	Problem should have symbolic structure the problem with available heuristics for its solution Optimum complexity level for human expert Problem size should be manageable and its solution has practical value.

Feasibility study and cost-benefit analysis

Whether the project is feasible should be evaluated. Economic, technical and organizational feasibilities, listed in Table 4.8.2, should be considered (Turban and Aronson, 2001).

Table 4.8.2. Elements of ES feasibility study

Economic (financial) feasibility: Should we build it?	Estimated development costs Estimated operating costs Anticipated befits Intangible benefits Intangible costs Cash flow analysis Risk analysis
Technical feasibility: Can we build it?	Familiarity with application Familiarity with technology Project size Interface requirements Networking issues Availability of knowledge and data Security of confidential knowledge Knowledge representation scheme Hardware and software availability and compatibility
Organizational feasibility: If we build it, will they come?	Project champion(s) Senior management support Management support Experts' support and availability User support, training and environment Other stakeholders Other resources Organizational and implementation issues Priority Need assessment and justification Legal and other constraints Corporate culture

source: (Giarratano and Riley, 2005, p.18; Turban and Aronson, 2001, p.559)

A cost-benefit analysis should follow the feasibility study in order to formally identify and estimate the potential costs and benefits of the system. Costs would be expected to mainly involve development, training and maintenance costs. On the other hand, benefits might involve reduced work stress, increased throughput, and increase in savings and/or profitability. Cost-benefit analysis should be repeated as its deemed necessary in further project phases as well.

Consideration of managerial issues

Typically, ES development team consists of expert(s), knowledge engineer, and IS systems analyst/programmer. Though cooperation and communication requirements are demanding, team approach is known as the best development arrangement (Wong, 1996).

There are various reasons for firms to engage with ES development; an acute need, a belief in promises of ES, in-house presence, availability at competitor might be a few to name. Regardless of the reason to initiate an ES development project, some managerial issues should be anticipated and precautions should be undertaken. All stakeholders of the project should believe in the project's value. Moreover, strong sponsorship from top management is favorable. As end-users support and training are critical, they should be involved at early phases of the project but not only in the implementation phase. Financial and technical sources should be available. Experts should be accessible. Lastly, legal constraints as well as environmental constraint in development and use of the system should be considered.

2. System Analysis and Design

After project is proved, system functionality should be estimated via detailed system analysis. The major tasks involved with system analysis and design are listed below (Turban and Aronson, 2001):

Conceptual design

Similar to an architectural sketch of a house, conceptual design provides clues on what the system is going to look like and how it is going to solve the problem. General capabilities, areas of risk, required resources should also be marked on the design.

Development strategy

In-house development, outsourcing or blended approach, in which external consultants join in-house teams, should be considered and the must suitable approach should be chosen. When skills and resources are available in-house development becomes an attractive choice. Alternatively, depending on the cost-benefit analysis

existing information technology personnel can be trained for the development to be handled in-house. On the other hand, outsourcing is possible via different means such as hiring a consultation firm for the entire effort, becoming a test site for a newly developed system, partnering with a university by sponsoring the development research, joining an industry consortium for an industry-wide system development, or acquisition of an artificial intelligence firm.

Sources of knowledge

Both human experts and documented sources are used in ES development. Length and complicatedness of knowledge acquisition is directly proportional with the need for human expertise. With such intense knowledge acquisition, the attributes of the human expert(s) becomes important. Here, the ideal attributes of an expert should be considered (Table 4.8.3).

Table 4.8.3. Ideal attributes of an expert

Have highly developed, specialized content knowledge
Are thoroughly familiar with the domain, including task expertise built up over a long-period of task performance, knowledge of the organizations that will be developing and using the ES, knowledge of the user community, and knowledge of technical and technological alternatives
Have a solid knowledge base and reputation so that the ES recommendations will be credible and authoritative
Are more creative than most people
Are aware of the difference between relevant and irrelevant information
Are able to simplify complexities
Are selective about which problems to solve
Have strong communication skills
Have highly developed perceptual attention
Know when to make exceptions
Have a strong sense of responsibility toward their choices
Have outward confidence in their decisions
Are able to adapt to changing task environments
Have greater automaticity of cognitive process
Are able to tolerate stress
Can commit a substantial amount of time to development of the system, including temporary work if necessary

Table 4.8.3. Ideal attributes of an expert (continues)

Are cooperative, easy to work with, and eager to work on a project
Are interested in computer systems

Source: (Chandler and Liang, 1990, p.56; Turban and Aronson, 2001, p.567)

Computing resources

There are two important computing resources that should be considered, i.e., hardware and software. Hardware together with its processing and memory power determines the software to be used. ES had been used to be programmed in special languages like LISP and PROLOG which demanded special hardware. However, today ES development is often undertaken either by conventional languages such as C++ or by shells. As both approaches run on standard hardware, widespread distribution and compatibility is assured.

ES software can be classified in five technology levels as shown in Figure 4.8.2. The ES application can often be constructed with shells, support tools, hybrid systems or languages. Similarly, shells and hybrid systems can be constructed with languages or support tools, and support tools can be constructed with languages. Higher level of software demands less programming. However, flexibility of software in handling nonstandard and complex applications reduces at high levels.

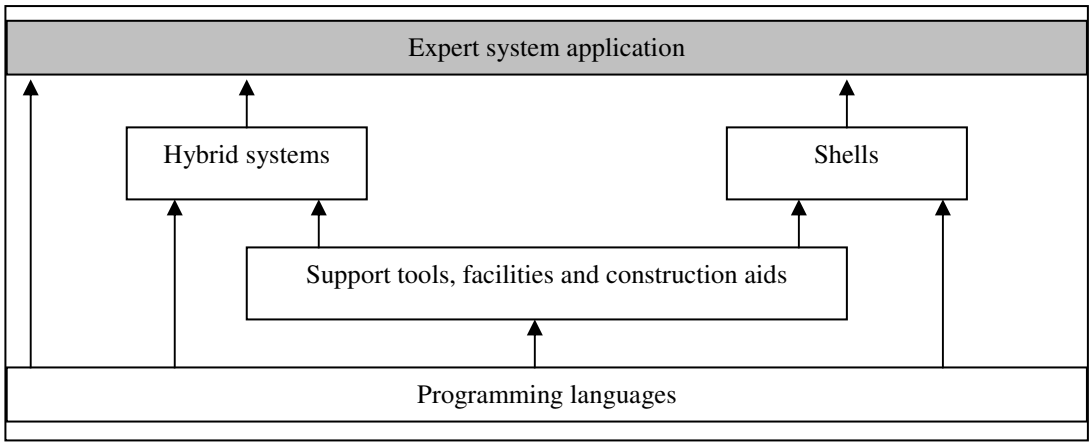

Figure 4.8.2. Technology levels of ES software (Giarratano and Riley, 2005, p.21; Turban and Aronson, 2001, p.568)

Expert system applications are systems that advise users upon consultation. Shells borrow largely from already built ES, where knowledge component is removed.

Preprogrammed for explanation and inference mechanisms, shells commonly include the user interface. Support tools are used to assist knowledge acquisition, knowledge validation and verification, and construction of interfaces to other software packages. Consisted of several support tools and languages, hybrid systems enable complex, multiple-knowledge representation systems to be built faster that the case when only programming languages are used. Programming languages, ranging from object-oriented languages such as cT to spreadsheet like Excel can also be employed in developing an ES. Most widely accepted fastest and easiest approach is to use shell. If a shell is affordable and available for the hardware in hand, then its capabilities in dealing with the chosen problem domain should be determined. Some initial knowledge engineering can be performed to verify the domain can be expressed properly in the shell's knowledge representations. In addition, a demonstration prototype can be built. It is strongly advised to make investment to shells that when ever there is fit between problem and shell specifications.

3. Rapid Prototyping and a Demonstration Prototype

As a small-scale system, the ES prototype includes knowledge representation that facilitates quick inferencing and creation of major ES components. Few rules are included to produce limited consultations in testing the proof of concept of the ES. This helps the builder to decide on the structure of the knowledge base before spending time on acquiring and implementing all rules. The process of rapid prototyping is shown in Figure 4.8.3. Following steps are followed in rapid prototyping and its demonstration:

Building a small prototype

Number of rules to be used and the segment of ES to be included in the prototype are determined by the designer. Relevant knowledge is represented in the ES.

Testing, improving, expanding

A test is conducted either by real/historical data or hypothetical cases. Results are judged, knowledge representation methods and software/hardware effectiveness are examined. If improvement is required, then the system is refined by redesign and tested again (Studt, 1994).

Completing design

Via several iterations, the system becomes ready as a prototype upon which the system development can be initiated.

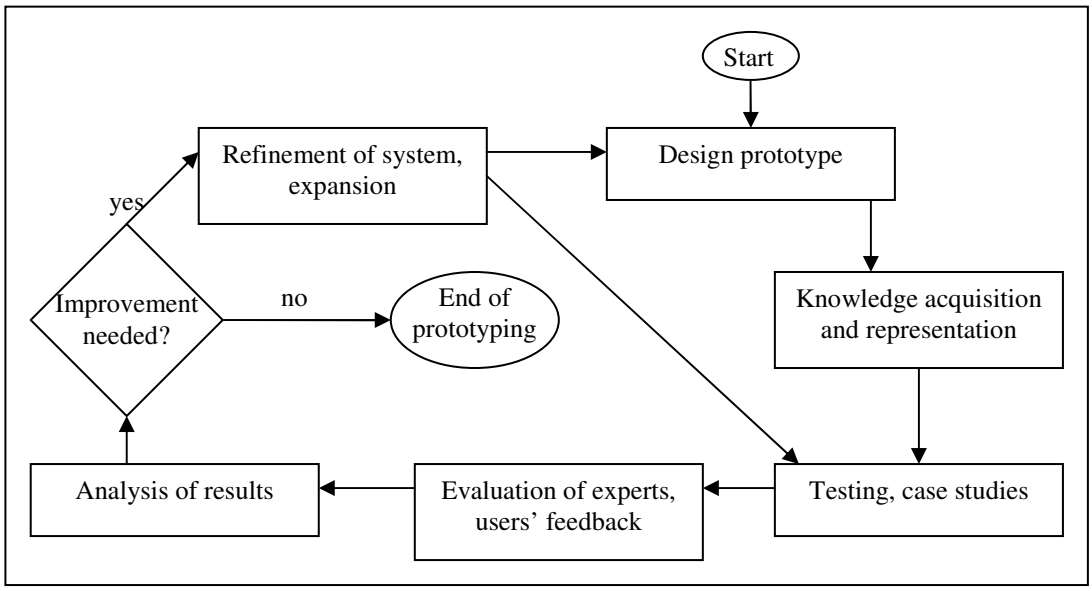

Figure 4.8.3. Rapid prototyping (Brasher and McAndrew, 2003; Schnupp, 2000; Turban and Aronson, 2001, p.578)

4. System Development

There are two viable system development approaches, continue with prototyping or use the traditional system development life cycle. The problem size, amount and type of required interfaces with other systems, dynamics of knowledge determine the development strategy. In either case, the lengthy and complex process of system development has three major factors:

Completing the knowledge base

Knowledge base construction consists of two major paces: (1) Knowledge acquisition, and (2) Knowledge representation.

Transfer and transformation of potential problem-solving know-how to software is known as the knowledge acquisition (Jackson, 1990). Table 4.8.4 lists direct and indirect techniques, as well as group and automated knowledge acquisition methods

(Grabowski and Wallace, 1997). Acquisition is followed by representation, at which knowledge is stored and categorized following a classification.

Table 4.8.4. Knowledge acquisition framework

Type of Technique			
Direct	**Indirect**	**Group Knowledge Acquisition**	**Automated Knowledge Acquisition**
Interview Observation Questionnaire Inferential flow analysis Drawing closed curves Hierarchical card sorting Protocol analysis Interruption analysis Context focusing Constrained processing Limited information Actual familiar tasks scenarios Tough cases Combined constraints	Recall order Direct judgment Confusion probabilities Co-occurrence probabilities Multidimensional scaling Hierarchical clustering Tree representations General weighted network Reported grid	Nominal group technique Delphi technique Social judgment analysis Reference groups Structured workshops Simulation models Brainstorming Focus group Groupware Group repertory grid Teleconferencing Interorganizational networks Hypermedia	Machine learning Knowledge base refinement Interactive computer-aided elicitation methods Knowledge discovery Data mining

Source: (Grabowski and Wallace, 1997, p.22)

Knowledge acquisition and representation should be finalized by using the appropriate methods. The domain knowledge organization requires all possible outcomes to be placed in a rule-based system in which each potential solution appears in the THEN portion of at least one rule. Identify and list all the facts and data that will be required by the system. Before writing the rules, prepare an outline; if possible organize the elements of knowledge into a tree format. Develop the rules to complete the knowledge base.

Testing, evaluating, and improving knowledge base

Test problems derived from historical or sample cases are fed into the system. Besides testing the knowledge, the entire system needs to be also tested (Adelman, 1992).

In business settings, ES can often be evaluated by experimentation. Each time a new case is present to ES, possible refinements should be undertaken. Each time a substantial refinement is made, an evaluation follows, too. Evaluation and refinement are iterative processes. Development continues as long as improvements are necessary. Once a system is deployed in the field, it is wise to attempt to capture knowledge from users to help refine it. Ensuring that the system will make reasonable recommendations, evaluation involves both validation and verification. Validation is revealing whether the right system was built or whether the system does what it was meant to do and at an acceptable level of accuracy. It should try to answer the following questions: (1) Is built ES the right system; (2) Is built ES's knowledge base correct; and (3) Is built ES doing the job it was intended to do? Thus, validation aims to determine that the completed expert system performs the functions in the requirements specification and is usable for the intended purpose. Issues investigated during validation also include (Regions) "How well do inferences made compare with historic (known) data?", in which Black-Box testing can be used (Awad, 1996). Black box testing refers to testing a system with no specific knowledge to the internal workings of the system, no access to the inference structure, and no knowledge of the architecture (Arkin, 2007). In essence, this approach most closely mimics how an attacker typically approaches an application. On the other hand, verification verifies that the ES has been built correctly according to specifications. It controls whether the system is built right (Giarratano and Riley, 1998); all specifications, structure and sequence of inferences are correct, knowledge base is complete, manipulation of knowledge by inference engine is proper (Regions). It is also possible to establish verification through White-Box testing (Awad, 1996). White box testing refers to testing a system will full knowledge and access to all algorithms and architecture documents (Arkin, 2007). Full access to inference engine structure can reveal if the program diverges from its intended goal.

For a complete examination, both white box and black box tests are required (Webodia, 2005).

5. Implementation

ES implementation can become a long and complex process. Issues that should be visited involve the following:

Acceptance by users

Though quality and ease of use stand important, user acceptance often depends on behavioral and psychological considerations (Suh and Suh, 1993). It is suggested to involve users in the development effort, since user satisfaction is positively related to user satisfaction in the development stages (McKeen and Guimaraes, 1997). Another key factor in user acceptance is the sufficient and high quality training provided to users. In cases where maintenance responsibility lies with the user, delivery of a fairly extensive training is critical to ES success.

Installation and deployment

When ES reach a certain level of stability, it becomes ready for field-testing, i.e., when it can handle 75% of the cases and exhibit less than 5% error rate in rule-based systems. Some cases might involve higher accuracy levels that are dictated by law. It is also possible to install the system in parallel with a human expert during a test period. Final system deployment modes range from stand-alone turnkey delivery to embedded systems into other present information systems.

Documentation and security

Printed manuals, online documentation, or both can be included in the documentation. A system overview, a technical description, a high-level map of the whole problem, maps of the individual tasks, an index of all the items within a knowledge base that depend on actions outside the knowledge base, a record for all computer files used, and printed versions and backups of all computer files used are recommended for the maintenance documentation. Similarly, an introductory brochure, the system overview, a brief user guide, and a means of encouraging users

to provide feedback on the system are recommended for the user documentation (Beerel, 1993).

ES may enclose proprietary knowledge of a firm, therefore might have value in terms of intellectual property. Substantial practical problems observed when environment is not restricted only to authorized access.

6. Post-Implementation

Once the system is deployed to users, there is a need for regular operation and maintenance activities. ES evolves over time; therefore its development is never really finalized. As experts train themselves on new cases or reorganize their knowledge, ES must also be revised (Beerel, 1993; McCaffrey, 1992). Moreover, software and hardware bugs should be fixed as they are detected and new software releases and hardware platforms should be welcomed with appropriate system upgrades (Karimi and Briggs, 1996; Prerau, 1990).

4.9 Summary

Starting from this chapter, attention is devoted to the third research question. This chapter introduced a review of literature which is relevant to the study of expert systems. History and theory of ES were provided. This is followed by a discussion on the main elements of ES. Next attention is devoted to outlining the differences between ES and conventional computer programs. Application areas of ES are discussed then. Particularly, ES literature is reviewed for production and operations management and service management in subsequent two sections. The penultimate section covers the benefits of ES. Finally, the ES development process is presented.

This next chapter provides an expert system approach for value creation upon supplier's provision of services in supplier-buyer interactions.

5. AN EXPERT SYSTEM APPROACH FOR SERVICE VALUE CREATION IN SUPPLIER-BUYER INTERACTIONS

This chapter provides expert system development for the exploratory model developed in Chapter 3 to explain perceived buyer value creation upon supplier's provision of services in supplier and buyer interactions. Drawing upon literature (Adelman, 1992; Arkin, 2007; Awad, 1996; Baker, 1988; Chandler and Liang, 1990; Giarratano and Riley, 1998; Grabowski and Wallace, 1997; Hartman, 1993; Huntington, 1985; Jackson, 1990; Jackson, 1998; Jayaraman and Srivastava, 1996; Medsker and Liebowitz, 1994; Metaxiotis, 2004; Metaxiotis, 2005; Metaxiotis et al., 2003; Metaxiotis and John, 2003; Metaxiotis et al., 2002; Prerau, 1990; Studt, 1994; Turban and Aronson, 2001; Waterman, 1985; Wong, 1996), employed ES development follows the outline discussed in Chapter 4.8. An expert system shell, namely EXSYS Corvid which is known to be amongst the most commonly and widely used expert system shells (Darlington, 2000), have been utilized to developed the proposed expert system. An attempt to answer the third research question has been provided by the ES developed, namely ESSER, in this chapter.

This chapter is organized as follows. The first section covers the problem initialization. This is followed by system analysis and design. The penultimate section covers rapid prototyping. Finally, system development is concluded. As the implementation and post-implementation phases of ES development fall into the company's commercial interests rather than the research's, they have not been undertaken in this development section. Scope has been limited to only research.

5.1 Project Initialization

The factors that should be taken into account in project initialization that were discussed in Chapter 4.8 have been visited in this Chapter for the proposed ES.

This research endeavor attempts at three interrelated research questions. First research question, *"Does supplier's provision of services generate superior or inferior perceived buyer value*" has been investigated in Chapter 2. Then, second research question, "*Why does provision of services within a supply chain create superior perceived buyer value"* has been investigated in Chapter 3. The last research question, "*What should a supplier provide in terms of services in order to create a superior perceived buyer value"* had been aimed at since Chapter 4. In this context, an ES is developed.

The domain examined involves non-numerical symbolic interpretations. These types of interactions are usually handled by computerized systems. Among these computerized systems, expert system is found to be the best serving methodology for providing an attempt to answer the third research question. There is a need for an application that would transfer supplier's human expertise in order to advise and explain complex decisions. These decisions are often undertaken by the use of unstructured rules where symbolic manipulation of factual and procedural knowledge is employed. The aim here is to design service offering levels for various buyers in order to generate superior perceived buyer at each buyer but keeping costs at minimum. These reasons have mainly influence the decision to undertake an expert system approach. Moreover, rather than pursuing a single uniform approach for all buyers, a customized approach for each buyer's service-level expectations depending on the comparison of operational mediums, would both enable optimization of supplier's service-level costs, and ensure perceived buyer value generation to be of superior.

As encounters involving perceived buyer value generation suggest, service-level requirements play a major role in an encounter between a supplier and a buyer. Even though, supplied items are often products with some quality standards to manufacture, transfer, handle etc., services rely on comparison of the buyer's operational medium to that of supplier's in receiving an assessment of superiority. Both, service providers' (supplier) and receivers' (buyer), stakeholders' services related knowledge and experience facilitate a subjective perceptional determination of quality services. The conceptual model developed in Chapter 3 is used in this

research for investigating the creation of superior perceived value in a supply chain encounter.

Companies involved in highly competitive superior service industries like automotive industry (Barsky et al., 2001) provide a good venue for this research as they "have little choice but to compete on service" that creates superior perceived buyer value (Barsky et al., 2001). Suppliers in the automotive industry develop their activity under constantly changing service level conditions, since buyers continuously demand more reduction in costs, as well as improvement in quality and service (Benavides et al., 2002). Therefore, major companies of the Turkish Automotive Industry have proved to be candidates. As one of the key drivers of contemporary Turkish economy, automotive industry is consisted of 18 automotive firms which manufacture trucks, buses, minibuses, commercial vehicles, and passenger cars. ES development process has been undertaken in collaboration with one of these firms.

The firm, which is a major stakeholder of the Turkish Automotive Industry and her 39 nationwide buyers (out of a total of 83 nation wide and 2 international buyers) participate in the ES development. Anonymity of all parties involved have been assured by the signed confidentiality agreement. Figure 5.1.1 shows the supply chain structure of the investigation site. The gray marked field denotes the scope of ES development approach.

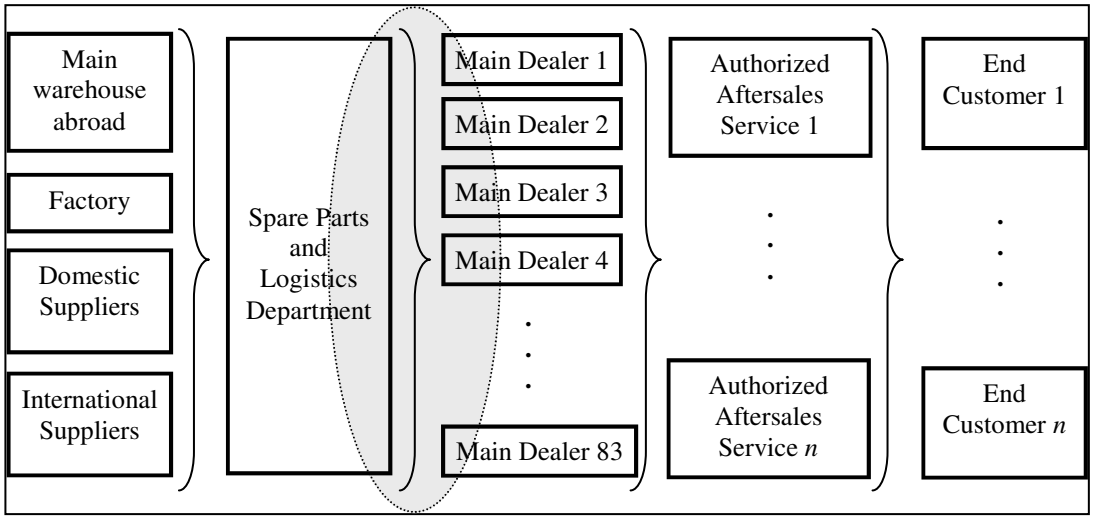

Figure 5.1.1. Supply chain structure of the investigation site

The development team consists of the researcher and the six human experts employed at the spare parts and logistics department of the supplier firm. Apart from a development with commercial interests, this ES development intends to conclude with consultation session; therefore implementation and post-implementation phases fall outside the scope.

5.2 System analysis and design

Conceptual design of the ES, namely **E**xpert **S**ystem Application for Suppliers to Create **Ser**vice Value (ESSER), is depicted in Figure 5.2.1. ESSER involves a knowledge base that contains the suggestions of actions for services provision, which are acquired from human experts for various cases that are likely to be encountered as result of differences in supplier's and buyer's operational mediums. A typical ESSER user is expected to be a supplier. A user interface is accommodated for feeding data about service dimensions of buyer and supplier. Inference engine conducts a comparison of supplier's and buyer's operational mediums, runs the rules knowledge base contains, and finally a suggestion is delivered to the supplier on what to do in terms of services for creating superior perceived buyer value. Thus, third research question is attempted for an answer.

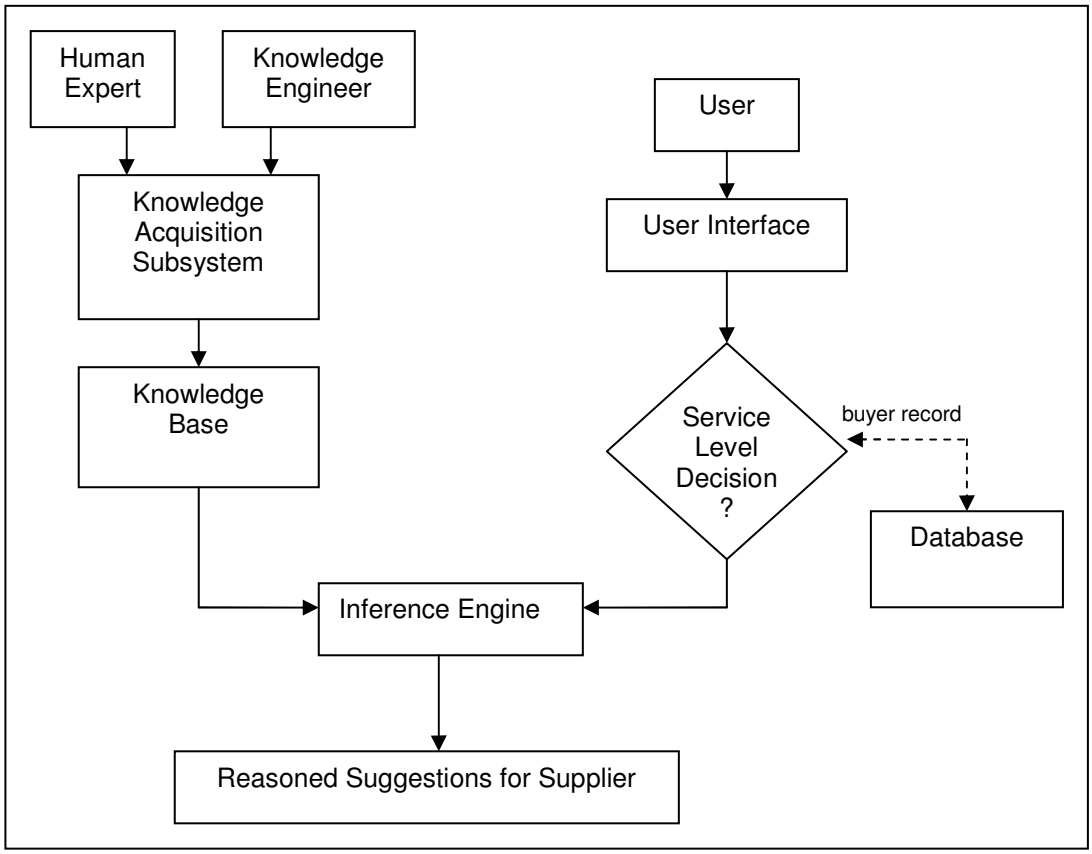

Figure 5.2.1. ESSER (**E**xpert **S**ystem Application for Suppliers to Create **Ser**vice Value)

This research utilizes an expert system shell, namely EXSYS Corvid, which is known to be amongst the most commonly and widely used expert system shells (Darlington, 2000). Development strategy involves the knowledge engineer to complete the task. Six human experts are engaged in the process. They are the personnel of the Spare Parts and Logistics Department, which maintains supplier relations with 83 nation wide and 2 international buyers. In line with the ideal attributes listed for human experts in Table 4.8.3, chosen human experts, (1) have highly developed, specialized content knowledge; (2) are thoroughly familiar with the domain, including task expertise built up over a long-period of task performance; (3) have a solid knowledge base and reputation so that the ES recommendations will be credible and authoritative; (4) are aware of the difference between relevant and irrelevant information; (5) are able to simplify complexities; (6) are selective about which problems to solve; (7) have strong communication skills; (8) have greater automaticity of cognitive process; and (9) can commit a substantial amount of time to development of the system, including temporary work if necessary.

5.3 Rapid prototyping

Knowledge acquisition in this research employed direct (i.e., interviews, observations, questionnaires), indirect (direct judgments) techniques as well as group knowledge acquisition for a duration of eight months with six human experts, where Delphi Method had been adapted as the major group knowledge acquisition technique. Researcher has served for the single knowledge engineer, and carried all knowledge acquisition stage by herself. Therefore, uniformity of investigated phenomena has been ensured. For eight months, a weekday is dedicated to observe and consult human experts. Therefore, it was possible to observe human experts while they handle orders and provide services. Group meetings have been conducted to deliver establishments of the previous chapters achieved in this research, where aim and scope have been delivered. Human experts have been familiarized with the theory in these meetings and in one-to-one contacts. First their experience based knowledge has been attempted at in group meeting format as part of the discussion. In addition, Delphi Method had been employed to further motivate their participation. They were provided with an empty form that questions what should be the questions to probe for the ten dimensions of services (tangibles, reliability, responsiveness, competence, courtesy, credibility, security, access, communication, and understanding the buyer). Driven by literature (Berry et al., 1990; Parasuraman et al., 1988; Parasuraman et al., 1985; Zeithaml et al., 2002; Zeithaml et al., 1990), a list of questions have been articulated upon discussions with six human experts. Table 5.3.1 lists these questions designed for being directed in the user interface for ES to conduct a comparison of buyer's and supplier's operational mediums. The list only attempts at covering the basics and is not exhaustive, future research might focus on improving it.

Table 5.3.1. Items and relevant questions used for knowledge acquisition from buyers on dimensions of service quality to determine their individual operational mediums

Service Quality Dimension	**Samples of Questions to Utilized Knowledge Acquisition from Buyers (Q)**
SQ1. Tangibles	Q1. Do you deem facilities' attractiveness as ...? * Q2. Do you deem formal dressing code as ...? * Q3. Do you deem materials' ease of understanding ... in your communications? * Q4. Do you perceive modern look of technology as ...? *
SQ2. Reliability	Q5. Do you deem keeping promises within certain time limitations as ...? * Q6. Do you deem communicating and following exact specifications as ...? * Q7. Do you deem statements or reports being free of error as ...? * Q8. Do you deem performing the service right the first time as ...? * Q9. Do you deem constant level of service at all times of day and by all members of staff as ...? *
SQ3. Responsiveness	Q10. Do you deem quickly responding to problems as ...? * Q11. Do you deem staff's willingness to answer questions as ...? * Q12. Do you deem providing specific times for service accomplishments as ...?* Q13. Do you deem treating public situations with care and seriousness as ...? *
SQ4. Competence	Q14. Do you deem providing service without fumbling around as ...? * Q15. Do you deem providing appropriate and up to date materials as ...? * Q16. Do you deem capability of staff in using technology quickly and skillfully as ...? * Q17. Do you deem staff appearing to know what they are doing as ...? *
SQ5. Courtesy	Q18. Do you deem pleasant demeanor of staff as ...? * Q19. Do you deem refraining from acting busy or being rude upon questions as ...? * Q20. Do you deem answering phones in a considerate and polite manner as ...?* Q21. Do you deem observing consideration of property and values of other party as ...? *

Table 5.3.1: Items and Relevant Questions Used for Knowledge Acquisition from Buyers on Dimensions of Service Quality to Determine their Individual Operational Mediums (continues)

Service Quality Dimension	**Samples of Questions to Utilized Knowledge Acquisition from Buyers (Q)**
SQ6. Credibility	Q22. Do you deem good reputation in terms of service as ...? * Q23. Do you deem refraining from pressuring the other party as ...? * Q24. Do you deem grant of responses accurate and consistent with other reliable sources as ...? * Q25. Do you deem guarantee of services as ...? *
SQ7. Security	Q26. Do you deem safe entry of premises and use of equipment as ...? * Q27. Do you deem secure hold of documents and other information provided as ...? * Q28. Do you deem keeping records safe from unauthorized use as ...? * Q29. Do you deem confident perception of correctly provided service as ...? *
SQ8. Access	Q30. Do you deem ease of reach to a knowledgeable staff member upon problems as ...? * Q31. Do you think ease of reach the appropriate person in person is ...? * Q32. Do you think ease of reach the appropriate person via telephone is ...? * Q33. Do you think ease of reach the appropriate person via e-mail is ...? * Q34. Do you deem convenience of service access points as ...? *
SQ9. Communication	Q35. Do you deem listening to problems, and demonstrating understanding and concern as ...? * Q36. Do you deem explanation of available various options to a particular query as ...? * Q37. Do you deem avoiding use of technological jargon as ...? * Q38. Do you deem informing about inabilities in attending previously scheduled appointments as ...? *
SQ10. Understanding the Buyer	Q39. Do you deem recognizing each regular contact by addressing personal name as ...? * Q40. Do you deem determining specific objectives as ...? * Q41. Do you deem consistency among the level and cost of services in terms of affordability as ...? * Q42. Do you deem flexibility of service provider in accommodating to other party's schedule as a(n) ... attribute? *

*: … resembles "important/unimportant" answer choices

Next, human experts were provided with an empty form that questions what should they improve in their services if their buyer's is placing more emphasize on tangibles, reliability, responsiveness, competence, courtesy, credibility, security, access, communication, or understanding the buyer. Assuring anonymity, their suggestions have been accumulated in a table, and they were sent the form second time, in which they were asked to read others' suggestions and provide any further opinion. This iterative process have been utilized until suggestions started to converge, there were in total 5 iterations. Table 5.3.2 lists the obtained suggestions.

Table 5.3.2. Knowledge acquired from human experts on advised actions

Service Quality Dimension (SQ)	Approaches of Human Experts
1. Tangibles	- prevent damages to packaging during delivery - pay attention to your outfit when you are to meet with the buyer
2. Reliability	- care for consistency, try to keep your promises, if that's not possible be prompt and honest, inform the buyer ASAP
3. Responsiveness	- answer all calls and deliver brief, quick and right answers (even when the answer is 'no') - send regular reports, set standards - keep smiling on the phone, your gestures show
4. Competence	- receive specialty training regularly and keep your know-how up-to-date - prevent employing different representatives for the buyer
5. Courtesy	- improve your empathic active listening skills and show courtesy to the buyer - arrange gifts for buyers' special days (birthday, holidays etc.)
6. Credibility	- let your buyer know that you are pursuing a win-win strategy
7. Security	- keep your buyer informed about the security measures imposed for their confidential data
8. Access	- check your e-mails regularly - reduce phone traffic by posting 'whom to call upon what' information online
9. Communication	- increase the frequency of face-face contact with the buyer at which your agenda should also include feedback sessions
10. Understanding the Buyer	- share good moments as well as bad moments of your buyer, keep track of events

This phase also involved determination of the operational level usage of the system in design. Initially ES was planned to be employed upon each and every inquiry from the buyer, however consultations with human experts did not prove support. Instead, yearly, or at most quarterly, employment seemed more adequate for the system to be value additive. The proposed usage frequency draws upon human experts' proposed idea that perceptions of services are dynamic and may change over a year's period, but would not vary significantly from day to day.

It was possible to gather data from 39 of the national buyers. Questions prepared with the guidance of human experts have been directed to buyers and responses have been represented on a "1-to-5 Likert Scale" (1-Very Unimportant; 2-Unimportant; 3-Neutral; 4-Important; 5-Very Important). All response data had been coded into a database.

ESSER's development goals include building a comparison of supplier's operational medium and buyer's operational medium on ten service quality dimension; decision trees for each had been designed and explained below.

Questions 1 (You deem facilities' attractiveness as …), 2 (You deem formal dressing code as …), 3 (You deem materials' ease of understanding … in your communications) and 4 (You perceive modern look of technology as …) have been used for Service Quality Dimension 1, Tangibles (Figure 5.3.1).

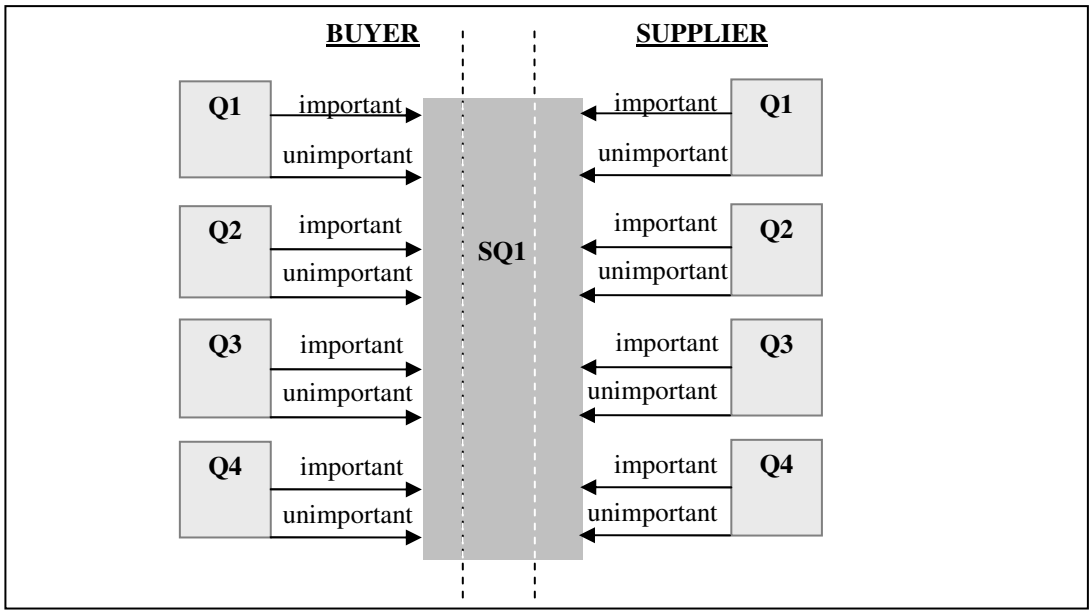

Figure 5.3.1. Decision tree for service quality 1, tangibles

Questions 5 (You deem keeping promises within certain time limitations as …), 6 (you deem communicating and following exact specifications as …), 7 (You deem statements or reports being free of error as …), 8 (You deem performing the service right the first time as …) and 9 (You deem constant level of service at all times of day and by all members of staff as …) have been used for Service Quality Dimension 2, Reliability (Figure 5.3.2).

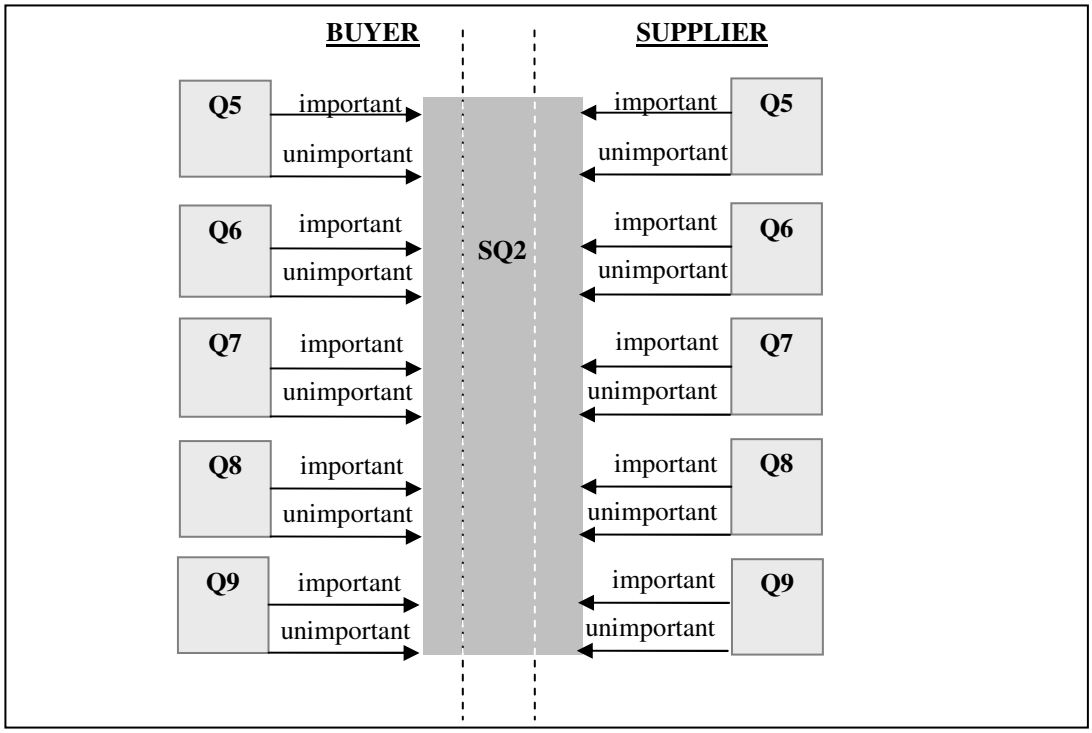

Figure 5.3.2. Decision tree for service quality 2, reliability

Questions 10 (You deem quickly responding to problems as …), 11 (You deem staff's willingness to answer questions as …), 12 (You deem providing specific times for service accomplishments as …) and 13 (You deem treating public situations with care and seriousness as …) have been used for Service Quality Dimension 3, Responsiveness (Figure 5.3.3).

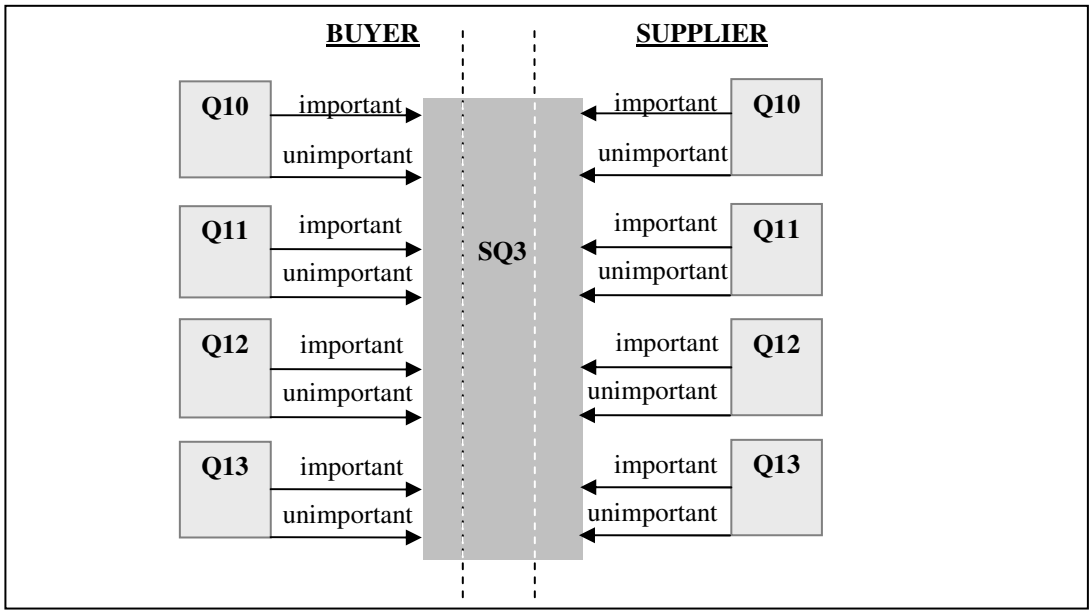

Figure 5.3.3. Decision tree for service quality 3, responsiveness

Questions 14 (You deem providing service without fumbling around as …), 15 (You deem providing appropriate and up to date materials as …), 16 (You deem capability of staff in using technology quickly and skillfully as …) and 17 (You deem staff appearing to know what they are doing as …) have been used for Service Quality Dimension 4, Competence (Figure 5.3.4).

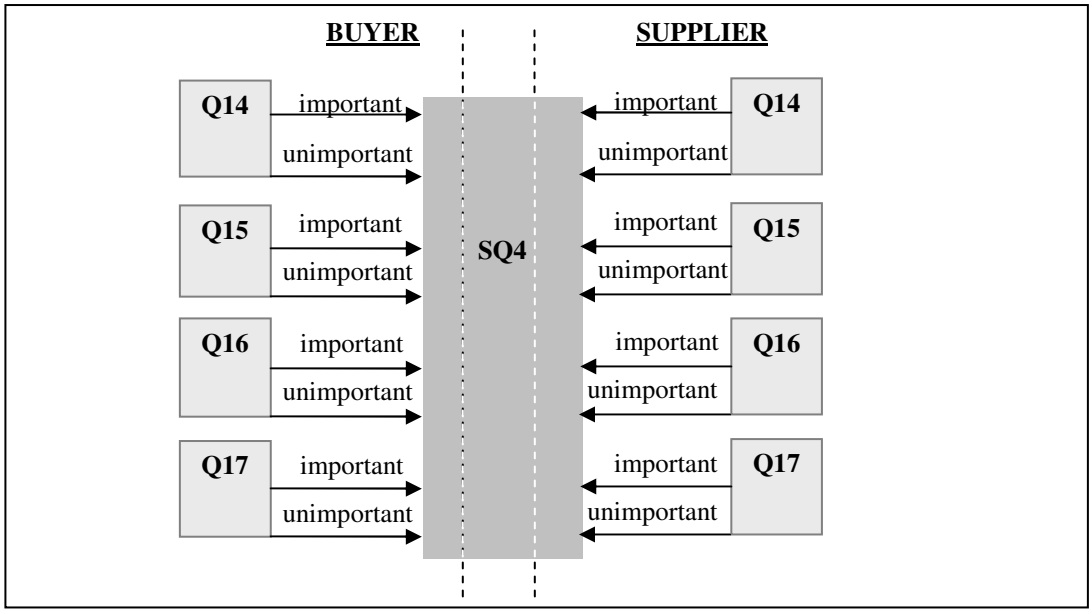

Figure 5.3.4. Decision tree for service quality 4, competence

Questions 18 (You deem pleasant demeanor of staff as …), 19 (You deem refraining from acting busy or being rude upon questions as …), 20 (You deem answering phones in a considerate and polite manner as …) and 21 (You deem observing consideration of property and values of other party as …) and have been used for Service Quality Dimension 5, Courtesy (Figure 5.3.5).

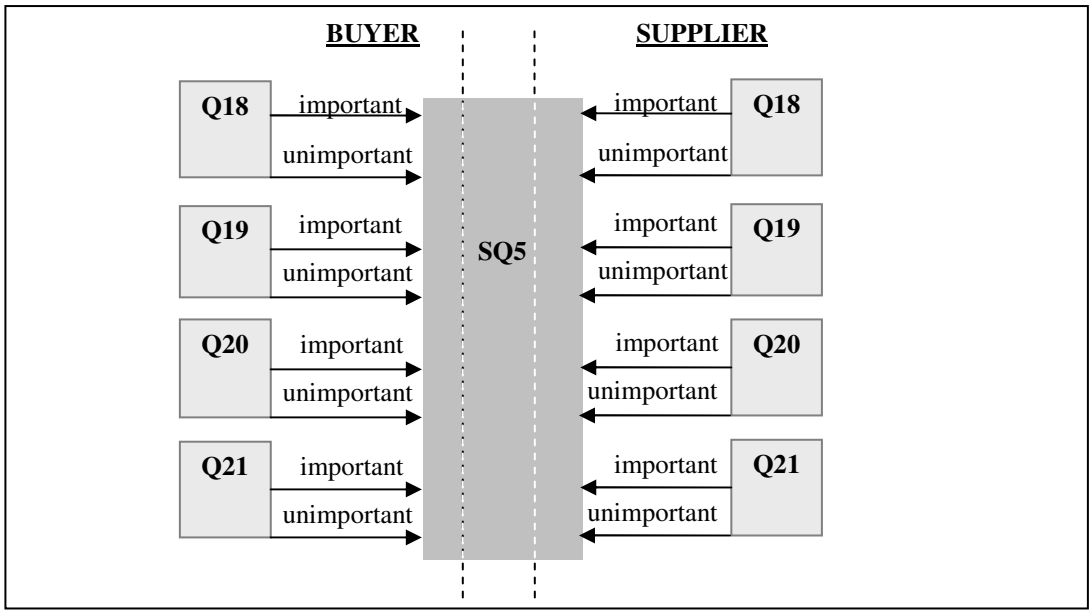

Figure 5.3.5. Decision tree for service quality 5, courtesy

Questions 22 (You deem good reputation in terms of service as …), 23 (You deem refraining from pressuring the other party as …), 24 (You deem grant of responses accurate and consistent with other reliable sources as …) and 25 (You deem guarantee of services as …) have been used for Service Quality Dimension 6, Credibility (Figure 5.3.6).

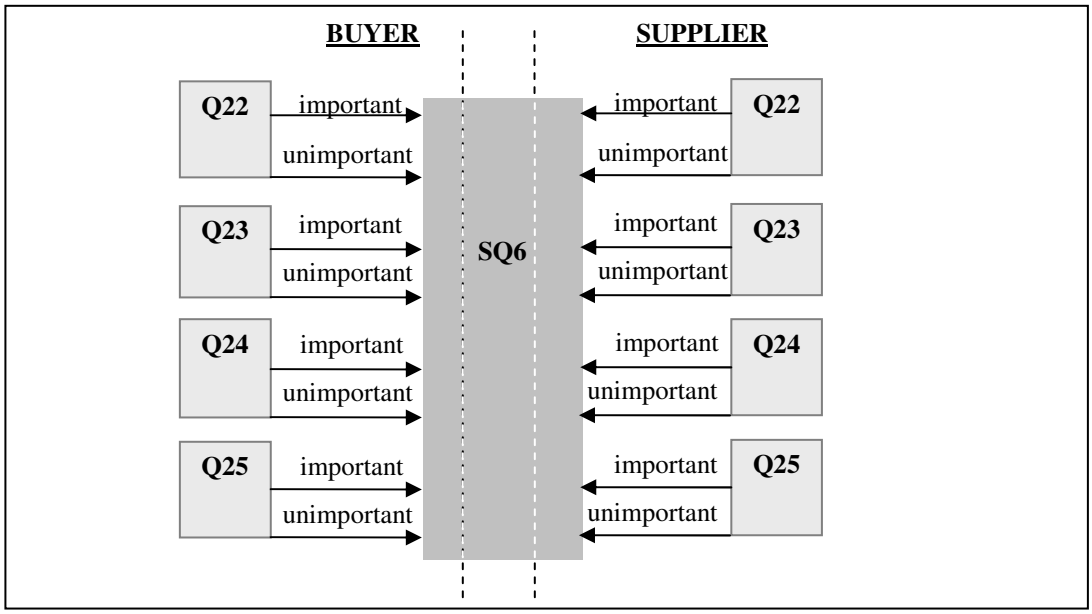

Figure 5.3.6. Decision tree for service quality 6, credibility

Questions 26 (You deem safe entry of premises and use of equipment as …), 27 (You deem secure hold of documents and other information provided as …), 28 (You deem keeping records safe from unauthorized use as …) and 29 (You deem confident perception of correctly provided service as …) have been used for Service Quality Dimension 7, Security (Figure 5.3.7).

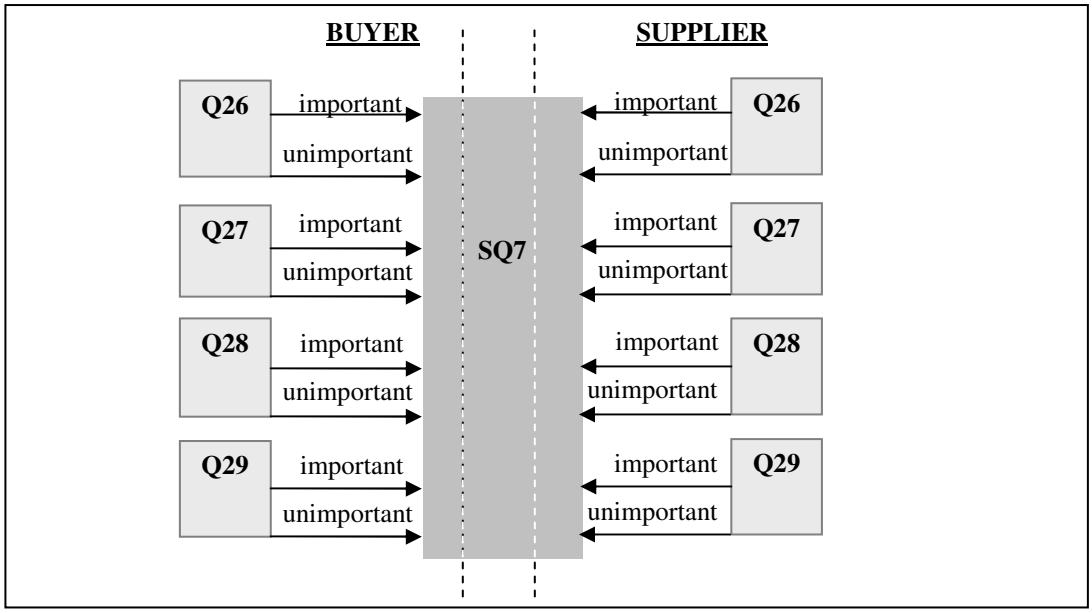

Figure 5.3.7. Decision tree for service quality 7, security

Questions 30 (You deem ease of reach to a knowledgeable staff member upon problems as …), 31 (You think ease of reach the appropriate person in person is …), 32 (you think ease of reach the appropriate person via telephone is …), 33 (You think ease of reach the appropriate person via e-mail is …) and 34 (You deem convenience of service access points as …)have been used for Service Quality Dimension 8, Access (Figure 5.3.8).

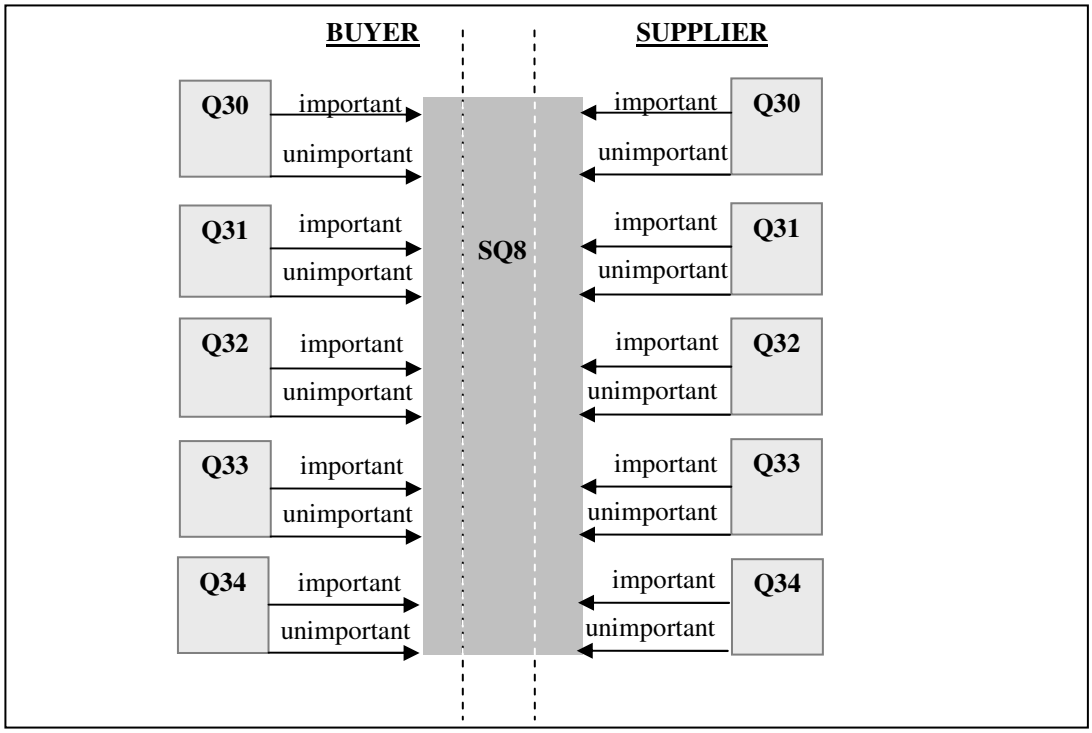

Figure 5.3.8. Decision tree for service quality 8, access

Questions 35 (You deem listening to problems, and demonstrating understanding and concern as …), 36 (You deem explanation of available various options to a particular query as …), 37 (You deem avoiding use of technological jargon as …) and 38 (You deem informing about inabilities in attending previously scheduled appointments as …) have been used for Service Quality Dimension 9, Communication (Figure 5.3.9).

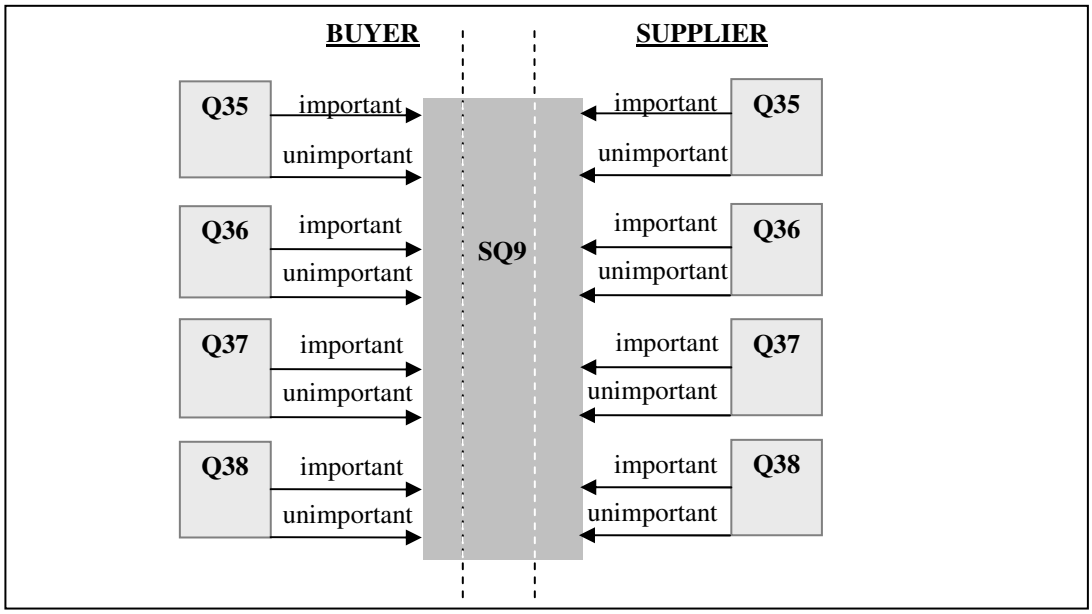

Figure 5.3.9. Decision tree for service quality 9, communication

Questions 39 (You deem recognizing each regular contact by addressing personal name as …), 40 (You deem determining specific objectives as …), 41 (You deem consistency among the level and cost of services in terms of affordability as …) and 42 (You deem flexibility of service provider in accommodating to other party's schedule as …) have been used for Service Quality Dimension 10, Understanding the Buyer (Figure 5.3.10).

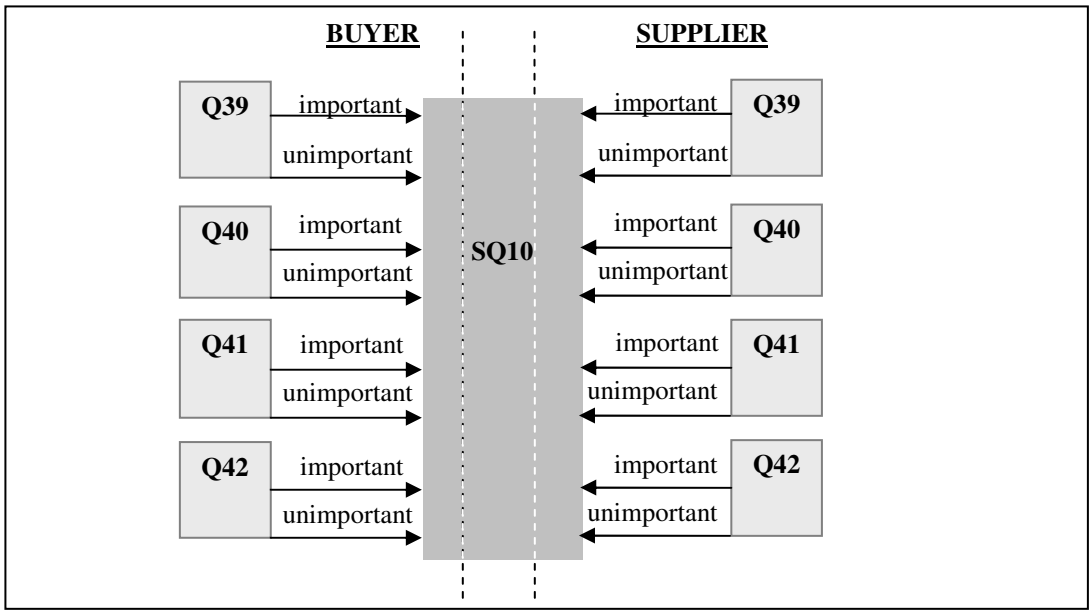

Figure 5.3.10. Decision tree for service quality 10, understanding the buyer

Moreover, the need for identifying the link between service quality dimensions with the dimensions of perceived buyer value had been investigated. Combinatorial correspondents have been left out of scope for simplification purposes. Upon consultation with human experts, following categories are set forward: through improvements on (1) *reliability* and *understanding the customer* (2) *responsiveness, competence, courtesy, access* and *communication*; and (3) *tangibles, credibility* and *security* perceived buyer value generation via *efficiency*, *effectiveness* and *differentiation*, respectively, shall be deemed possible (Table 5.3.3). Further research might focus on improving this categorization.

Table 5.3.3. Suggested service quality and perceived buyer value combinations

Perceived Buyer Value Dimension (S)	Service Quality Dimension (SQ)
S1. Efficiency	SQ4. Competence
	SQ10. Understanding the Buyer
S2. Effectiveness	SQ2. Reliability
	SQ3. Responsiveness
	SQ5. Courtesy
	SQ8. Access
	SQ9. Communication
S3. Differentiation	SQ1. Tangibles
	SQ6. Credibility
	SQ7. Security

Figure 5.3.11 shows the principle working mechanism developed for the ESSER. Upon user input on ten service quality dimension for both buyer and supplier, corresponding perceived buyer value creation possibilities are checked. Then, in cases where an opportunity for supplier's to improve services provided for further perceived buyer value creation, a suggestion is delivered.

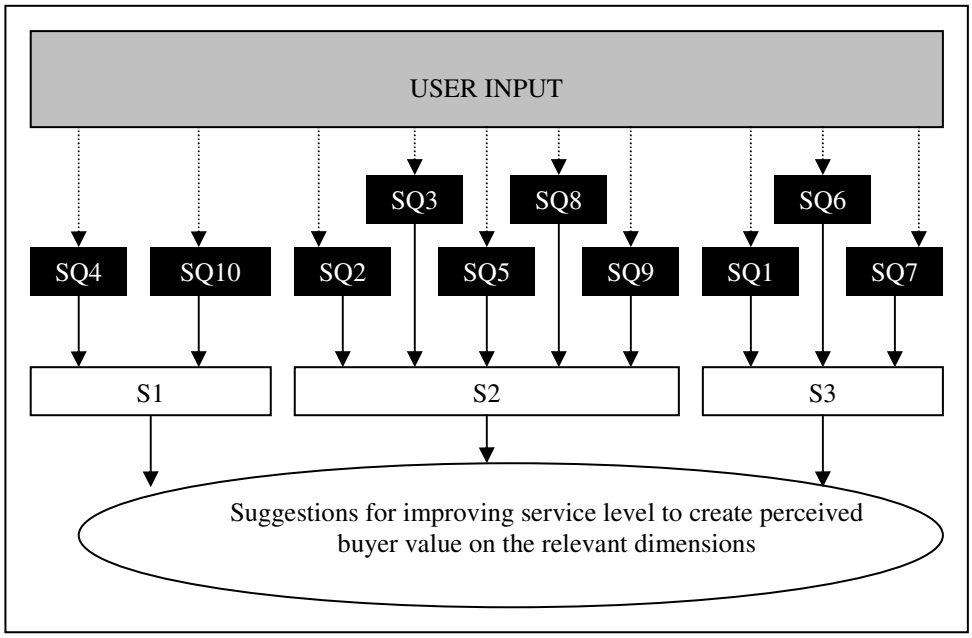

Figure 5.3.11. Principle working mechanism

In this context, a three parts inference engine had been designed in 8 refinement iterations. For the purposes of comparing buyer's and supplier's operational mediums, 84 static, 10 numeric, 10 string variables are used and 94 rules are designed in EXSYS Corvid. Same questions are probed for buyer and supplier. Assigned scores for user's answers are 20 or 25 as advised by the EXSYS Corvid manual. Buyer's positive (important) answers are assigned with positive scores, while supplier's negative (unimportant) answers are assigned with negative scores. System delivers suggestions depending on the "+/-" sign of the computed confidence interval value for the specific service quality dimension, and its corresponding dimension for perceived buyer value. First part of ESSER's Inference Engine (Figure 5.3.12) is used to detect any opportunities to create perceived buyer value via *efficiency* dimension. Here, questions Q14-Q17 and Q39-Q42 are used to compare SQ4 and SQ10, respectively. Second part of ESSER's Inference Engine (Figure 5.3.13) is used to detect any opportunities to create perceived buyer value via *effectiveness* dimension. Here, questions Q5-Q9, Q10-Q13, Q18-Q21, Q30-Q34 and Q35-Q38 are used to compare SQ2, SQ3, SQ5, SQ8 and SQ9, respectively.

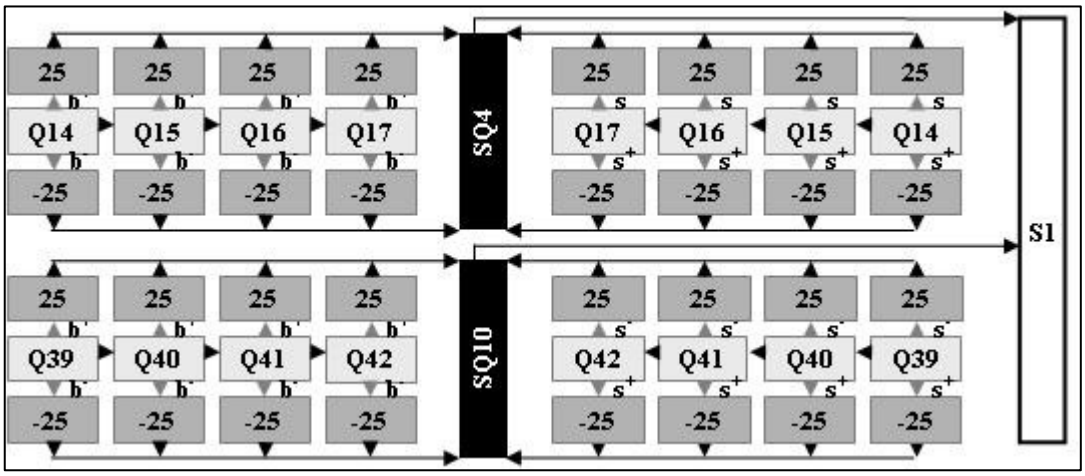

Figure 5.3.12. Efficiency perceived buyer value part of ESSER's inference engine

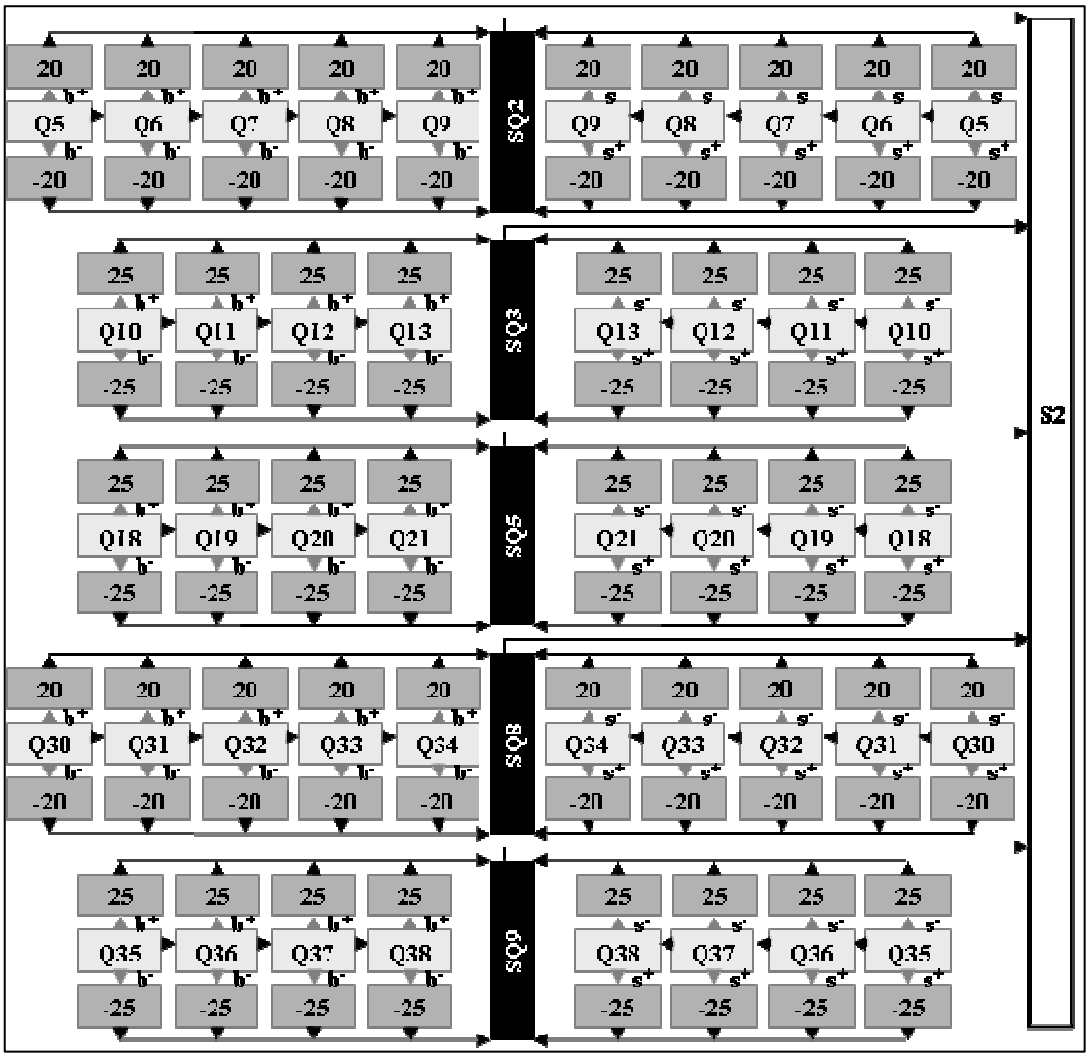

Figure 5.3.13. Effectiveness perceived buyer value part of ESSER's inference engine

Third part of ESSER's Inference Engine (Figure 5.3.14) is used to detect any opportunities to create perceived buyer value via *differentiation* dimension. Here, questions Q1-Q4, Q22-Q5, and Q26-Q29 are used to compare SQ1, SQ6, and SQ7, respectively.

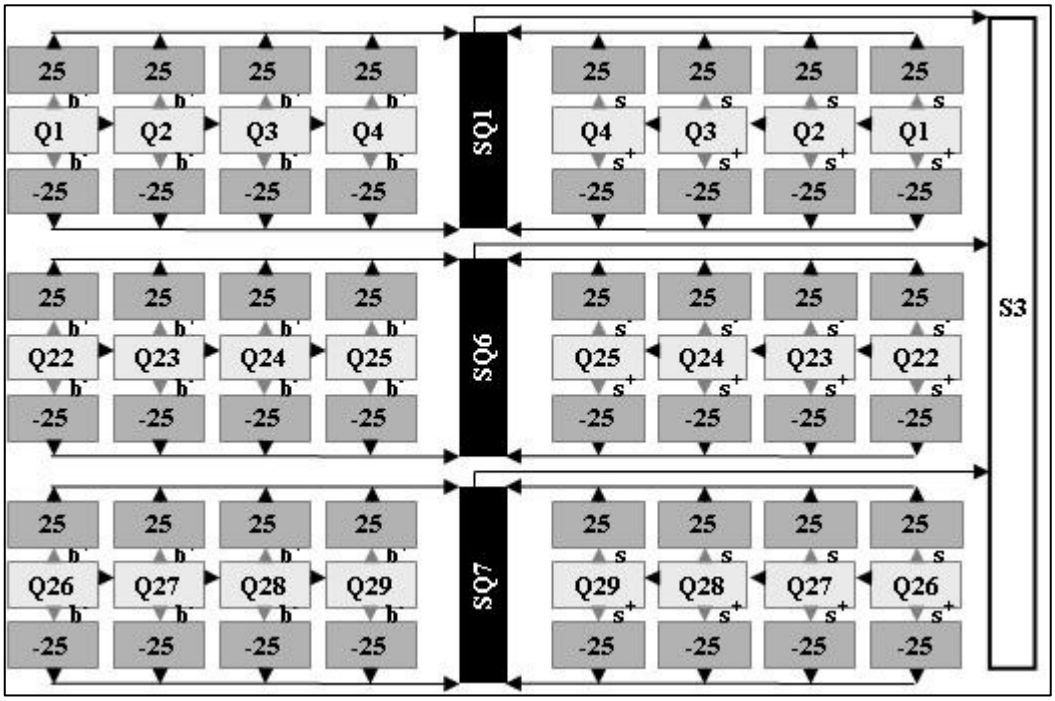

Figure 5.3.14. Differentiation perceived buyer value part of ESSER's inference engine

Rules and confidence values (Figure 5.3.15) set for buyer data on Service Quality Dimension 1 (Tangibility) are as follows:

Ask BUYER:

"**You deem facilities' attractiveness as …**"

- If "important" then add "25" to service quality dimension 1's confidence interval.
- If "unimportant" then add "-25" to service quality dimension 1's confidence interval.

Proceed to second question of service quality dimension 1.

"**You deem formal dressing code as …**"

- If "important" then add "25" to service quality dimension 1's confidence interval.

- If “unimportant” then add “-25” to service quality dimension 1’s confidence interval.

Proceed to third question of service quality dimension 1.

“When employed in your communications, your buyer deems materials' ease of understanding as …”

- If “important” then add “25” to service quality dimension 1’s confidence interval.
- If “unimportant” then add “-25” to service quality dimension 1’s confidence interval.

Proceed to forth question of service quality dimension 1.

“**You perceive modern look of technology as …**”

- If “important” then add “25” to service quality dimension 1’s confidence interval.
- If “unimportant” then add “-25” to service quality dimension 1’s confidence interval.

Ask SUPPLIER:

“**You deem facilities’ attractiveness as …**”

- If “important” then add “-25” to service quality dimension 1’s confidence interval.
- If “unimportant” then add “25” to service quality dimension 1’s confidence interval.

Proceed to second question of service quality dimension 1.

“**You deem formal dressing code as …**”

- If “important” then add “-25” to service quality dimension 1’s confidence interval.
- If “unimportant” then add “25” to service quality dimension 1’s confidence interval.

Proceed to third question of service quality dimension 1.

“When employed in your communications, your buyer deems materials' ease of understanding as …”

- If “important” then add “-25” to service quality dimension 1’s confidence interval.

- If “unimportant” then add “25” to service quality dimension 1’s confidence interval.

Proceed to forth question of service quality dimension 1.

“**You perceive modern look of technology as …**”

- If “important” then add “-25” to service quality dimension 1’s confidence interval.
- If “unimportant” then add “25” to service quality dimension 1’s confidence interval.

Compute service quality dimension 1’s score.

- If service quality dimension’s score is greater than zero, then display: “Opportunity to create perceived buyer value by Differentiation dimension. Improve Tangibility service quality dimension by (1) preventing damages to packaging during delivery; (2) paying attention to your outfit when you are to meet with the buyer”
- If service quality dimension’s score is less than zero, then do not display a suggestion.

Buyer Data

```
1  b_q1 = important
2      --> [SQ_1] = 25
3  b_q1 = unimportant
4      --> [SQ_1] = -25
```

Supplier Data

```
1  s_q1 = unimportant
2      --> [SQ_1] = 25
3  s_q1 = important
4      --> [SQ_1] = -25
```

```
1  b_q2 = important
2      --> [SQ_1] = [SQ_1]+25
3  b_q2 = unimportant
4      --> [SQ_1] =[SQ_1] -25
```

```
1  s_q2 = unimportant
2      --> [SQ_1] = [SQ_1]+ 25
3  s_q2 = important
4      --> [SQ_1] = [SQ_1]-25
```

```
1  b_q3 = important
2      --> [SQ_1] = [SQ_1]+25
3  b_q3 = unimportant
4      --> [SQ_1] =[SQ_1] -25
```

```
1  s_q3 = unimportant
2      --> [SQ_1] = [SQ_1]+25
3  s_q3 = important
4      --> [SQ_1] =[SQ_1] -25
```

```
1  b_q4 = important
2      --> [SQ_1] =[SQ_1]+ 25
3  b_q4 = unimportant
4      --> [SQ_1] = [SQ_1]-25
```

```
1  s_q4 = unimportant
2      --> [SQ_1] = [SQ_1]+25
3  s_q4 = important
4      --> [SQ_1] =[SQ_1] -25
```

Logic block to finalize the related computation of SQ1 relevant data

```
1  [SQ_1] >0
2      --> [sugSQ1] = "Opportunity to create perceived buyer value by Differentiation dimension. Improve Tangibility
           service quality dimension by (1) preventing damages to packaging during delivery; (2) paying attention to
           your outfit when you are to meet with the buyer"
3  [SQ_1] <0
4      --> [sugSQ1] = " "
```

Figure 5.3.15. Logic blocks for SQ1

Logic blocks for SQ2, SQ3, SQ4, SQ5, SQ6, SQ7, SQ8, SQ9 and SQ10 are included in the appendix A.

5.4 System development

This phase in ESSER's development included field-testing and improving. To serve this purpose, data on supplier's and some buyers' have been collected by the aid of the questions designed in Chapter 6.3 on a two scale *"important/unimportant"* format for the researcher to feed them into the system. Supplier's data have been collected from the employees and the manager of spare parts and logistics department. Next, coding to a database followed. To represent a single answer on behalf of the supplier for each question, scores had been merged. Whenever a conflicting case appeared with opposite answers from the employees, the negative answer had been chosen to represent the supplier's answer as the possible minimum service level provision's inclusion was aimed in the data set. Buyers' data have not

been subject to such needs; therefore have been only coded to the database for further use.

Further tests involved first White-Box testing for verification purposes. Several tests have been undertaken; a sample is available in detail in Chapter 6.4. As the sample data have been fed into ESSER, it was deduced that the several confidence intervals have been misplaced. Therefore, a revision is applied to ensure the planned inference engine's development. Subsequent to these minor refinements and re-tests, it was concluded that the system is built right; all specifications, structure and sequence of inferences are correctly developed. In addition, ESSER developed covered all the requirements set forward in the exploratory model discussed in Chapter 3 as its inference engine compares service quality in ten dimensions among supplier and buyers, and puts forward tactical suggestions for cases where "*supplier's operational medium* < *buyer's operational medium*" is detected. From this perspective, design goals are reflected in the developed expert system (Giarratano and Riley, 1998).

Moreover tests of validation have been employed to answer the following questions: (1) Is ESSER the right system?; (2) Is ESSER's knowledge base correct?; and (3) Is ESSER doing the job it was intended to do? Here, Black-Box testing approach has been adapted first and suggestions delivered for system for deduced cases have been investigated. Next, these suggestions have been compared to human expert's decision for the same cases for the modified Turing test (Turban and Aronson, 2001). Human experts have agreed on the suggestions ESSER provides for the fed cases.

It should be noted that the ES developed is limited to the model simplified. Moreover, certain limitations in terms of human expertise only belonging to automotive industry setting might apply. Besides, the very nature of ES calls for continuous development. Future research might focus on this issue. Another note that the note, the researcher would like to emphasize here is that, ESSER development undertaken have only served the purposes of a research endeavor. Though, company collaborated with can employ the deliverables of this research for commercial purposes with some minor future work. As the implementation and post-implementation phases of ES development fall into the company's commercial interests, they have not been undertaken and scope was limited to only research.

5.5 Summary

This chapter provided a thorough investigation of the third research question by developing an expert system, ESSER (Expert System Application for Suppliers to Create Service Value). First, problem initialization phase of ES development life cycle was provided. This is followed by system analysis and design phase. Next attention is devoted to rapid prototyping phase. Finally, system development phase is presented and development is concluded.

This next chapter provides an application of ESSER in the automotive industry.

6. AN APPLICATION IN AUTOMOTIVE INDUSTRY

This chapter provides an application of ESSER from an automotive industry. The first section presents the background information on automotive industry. This is followed the information on Turkish Automotive Industry. Penultimate section introduces the application site. Finally, application is reported by basic findings on 39 cases, and in detail, on one case.

6.1 Automotive Industry

Automotive industry is one of the most large scale global organizations, producing more than 60 million vehicles per annum. The stiff competition industry faced during the last couple of decades diminished the number of surviving firms, hence the market is dominated by a few, and market entry costs are sky-rocketing (Humphrey and Memedovic, 2003).

On a global scale, 15% of steel, 25% of glass, 50% of gasoline and 50% of rubber produced are consumed by the automotive industry. 10% of industrial businesses are related with automotive industry. 25.000 employer, 250 different firms and 8 different industries are needed to produce 100.000 vehicles. North America and Europe are the largest automotive markets. West Europe, United States and Japan go through stagnation in automotive production, while volume of production in East Europe, India and China enjoy a growth. China alone aims to capture 30% of car market share by the year 2012 (A.M.A., 2007).

Particularly in developed countries, automotive industry is primarily considered as a national one, independent of the internationalized developed by its business. As a representative of a country's manufacturing industry, automotive industry had been assigned the responsibility of serving the best interests of the nation. For these reasons, it was unthinkable about 20 years ago that the major automotive manufacturers would merge beyond national borders. Being the first one in the

history, the Daimler-Chrysler mega merger in 1998 involved 2 huge players producing from 1.2 million to 3 million cars annually. Prior to this, there have been only buy-ups of automotive makers across national boundaries (Shimokawa, 1999). The transformation in the industry is not only limited to mergers and acquisitions. Perhaps more dramatic and unprecedented transformation is also taking place in terms of how automotive companies define themselves. The model of the car company that Henry Ford created and Alfred Sloan perfected—integrated, scale-driven, "product-push"- oriented—prevailed for decades. It drove the consolidation of the U.S. industry from dozens of manufacturers to a mass. It governed the development of the post-war European industry, albeit with fits and starts engendered by that region's distinctive social and cultural politics. And it was the model upon which the Japanese manufacturers relied as they shot up the global league tables having made timely and effective adaptations that were overlooked, for a while, by the once-dominant U.S. industry. However, the traditional automotive company is prone to dangers brought by current market trends. Alternative contemporary visions and concepts have emerged for every piece of value that the traditional automotive company adds by designing, engineering, manufacturing, assembling and marketing vehicles (B.A.H., 1999).

Nowadays, unprecedented levels of customer value are delivered by the global automotive industry. With regard to economy, safety, comfort, functionality, and performance, automobiles manufactured today are vastly superior to what had been produced a decade ago. Among the many drives in this development, fierce global competition has a major role (BERA, 2004). Today, it is suggested that the globalization of the automotive industry, has greatly accelerated during the last half of the 1990's due to the construction of important overseas facilities and establishment of mergers between giant multinational automakers (Hiroaka, 2001).

The following factors are among the trends identified in the global automotive market (Hiroaka, 2001):

Global Market Dynamics - Automotive manufacturer leaders carry on investing into emerging markets for production facilities in an effort to decrease production costs. Latin America, China, Malaysia and other markets in Southeast Asia are among these emerging markets.

Establishment of Global Alliances - "The Big Three" (GM, Ford and Chrysler) U.S. automotive companies have merged with, and in some cases formed commercial strategic partnerships with, other European and Japanese automotive manufacturers. There is a trend for overseas expansion.

Industry Consolidation – Amid globalization, three tiers of automotive producers emerged:

- 1st Tier Company Mergers - Volkswagen-Lamborgini; BMW-Rolls Royce
- 2nd Tier Company Mergers - Chrysler-Mercedes Benz; Renault-Nissan-Fiat
- 3rd Tier Company Mergers - Mazda-Mitsubishi; Kia-Volvo

Leading global automotive makers and markets are North American, European Union, and East Asian:

North American Automotive Market: Among all industries in U.S., the automotive industry is one of largest and fundamental one, regarding the employment and productivity it enables. More than 5% of private sector GDP is created by automotive industry (Polly, 2002), more than 12.2 million vehicles are produced every year (Ward, 2003). Change in organizational and technological domains also surrendered U.S. automotive industry and forced it to seek overseas alliances and collaborations. "The Big Three" automotive companies dominate the market by producing approximately 76% of passenger cars. Japanese companies, Toyota, Honda, Nissan, Mitsubishi, Subaru, Isuzu, and European automakers, BMW and Mercedes (division of Daimler-Chrysler), hold 18% and 2 % of market share, respectively (Ward, 2003).

In contrast to its Japanese and European counterparts, U.S. automotive industry does not rely significantly on foreign exports. However, there is a great reliance on the domestic market, and to some degree, on the Canadian market. The U.S.-Canadian Automotive Products Trade Agreement had been established in 1965, since then Canada accounts for most of the automobile imports and subsidiaries of U.S.

European Automotive Market: The European Union is made up of 27 member states, and any European country with which accession negotiations are continuing. The EU is the world's largest automotive manufacturing region and the world's largest market (Lung, 2004). The European automotive industry represents approximately 9 % of the EU manufacturing sector (Europa, 2005). Being a leader in

the global market, it has integrated operations consisting of research, design, development, production and sales. Combined EU automotive industry production exceeds that of U.S. and Japan. The importance of the automotive industry on the economies of individual EU countries varies country to country. Polly (2002) reports that automotive production in Germany, Sweden, France and Spain represents approximately 10 % of total manufacturing, while the average for the EU is about 8 %. Germany is the largest producer and has 30 % of EU's total production. It is followed by France, Spain and United Kingdom by levels at 19%, 17%, 10%, respectively. EU has more than 20 vehicle manufacturers. It is common for largest automakers to produce multiple brands, i.e., General Motors, Ford, DaimlerChrysler, Volkswagen, Fiat and Peugot Citroen. There are also independent automakers like Porsche, BMW and Bertione. There has been an increase in production over the last decade at which exports to non-EU countries accounted 20% of overall production. Similar to other regional markets, EU auto industry has also practiced substantial restructuring and consolidation. There have been mergers, e.g., ChryslerDaimler-Benz, and acquisitions, e.g., GM acquisition of Saab, Ford's acquisition of Jaguar and Volvo's passenger car division, BMW's take over and then sale of Rover, and Volkswagen's acquisition of Bentley, Lamborgini, SEAT and Skoda.

East Asian Automotive Market: The Asian automotive market encompasses three 'core' markets, Japan, South Korea and China. The Korean and Chinese automotive markets continue to grow rapidly, at which they are expected to surpass Japan within a decade (Veloso and Kumar, 2002). Starting from 1990 Asian financial crisis, automotive industry challenged a decreased demand for a decade. Nonetheless, strong production growth of the national industry signals a potential leading position even for a worldwide growth trend. Foreign direct investment (FDI) has also enjoyed a growth since new millennium. In addition, there have been undertakings by both the U.S. and European automakers to collaborate with Asian automakers.

Japan's Automobile Industry: Significant portion of Japan's economy rely on automotive industry. 13% and 10% of manufacturing and employment, respectively, originates from automotive industry. Japan houses 11 automobile manufacturers which involve Toyota Motor Corp., Honda, Nissan, Mazda Motor Corp., Isuzu Motors, Ltd., Suzuki Motor Corp., and Fuji Heavy Industries, Ltd., and Daihatsu

Motor Co. Majority of these companies also have manufacturing plants in U.S. except for Suzuki and Daihatsu. Japan is the third largest automotive producer. Largest export market is U.S. Japanese automotive companies had been struggling with macroeconomic stagnation as well as decreasing demand. Some plants have been closed, while production capacity had been reduced in most. Besides, equity ownership to foreign automakers had been offered to receive financial and managerial assistance. For example, GM has equity in Suzuki and Subaru and controlling interests in Isuzu; Ford has majority equity in Mazda; DaimlerChrysler has majority equity control in Mitsubishi; and Renault has controlling interests in Nissan. The Japanese automotive industry relies heavily on exports. Compared to that, imports are very low, where Germany holds 70% the trade.

South Korea's Automobile Industry: Hyundai, Daewoo, Kia, Samsung, Asia Motors, Jinda, and Ssanyong are among the South Korean automotive manufacturers. South Korea exports 41% of all its production, of which 35% is to U.S. Being the third largest exporter, South Korea is the 6th largest automobile market with almost negligible imports. Foreign auto imports were prohibited, and Japanese automotive imports were not allowed permitted until years 1987 and 1999, respectively. Ongoing global restructuration also affected South Korea. In 1999, Hyundai acquired Kia and Asia Motors, and sold 10 % of its equity to DaimlerChrysler in 2000; Daewoo purchased 52 % equity in Ssanyong in 1998; and GM purchased 42 % equity of Daewoo; and in 2000, French automaker Renault purchased Samsung Motors. Currently, there aren't any independent automotive companies.

China's Automobile Industry: Automotive industry in China experiences a steady growth. It is projected that by 2010, China will become one of the world's largest automobile markets with domestic production reaching 5 million units (Veloso and Kumar, 2002). There are 120 manufacturers and approximately 2 million workers are employed in the automotive industry. The FAW Group, China's first large-scale motor vehicle producer, has an agreement with Volkswagen to produce Jetta's and Audi sedans. Dong Feng, the second largest automaker, has three major production facilities in the Hubei province. The Shanghai Motor Group, the third largest automotive producer, was established in 1960's. Since 1980's it had been involved in a joint-venture with Volkswagen. China's domestic automotive industry is protected

and nurtured via government initiatives and policies. Moreover, foreign auto imports are subject to strict trade barriers and harsh tariff policies. Despite its growth, Chinese automotive industry productivity lags behind the other Asian competitors. There is a lack in research and development; foreign partners are usually relied upon for new product development.

6.2 Turkish Automotive Industry

The automotive industry holds an imperative responsibility in both industrialization and globalization. It fosters various industries from extraction of raw material to the field of advanced management science, while providing mass employment, national income, and socio-economic growth. As one of the key drivers of contemporary Turkish economy, automotive industry is consisted of 18 automotive firms which manufacture trucks, buses, minibuses, commercial vehicles, and passenger cars (Table 6.2.1). Turkish Tractor had been the first firm founded in the sector, while Hattat Tarim is the latest. Istanbul, Bursa, Sakarya triangle in the north-west of Turkey houses majority of the sector. All manufacturers display oligopolistic characteristics, and the Koc and Sabanci groups hold the majority share of the industry (Bulu and Eraslan, 2004).

Table 6.2.1. General information on the automotive manufacturers – 2007

FIRMS	**Production Place**	**Initial Production Date**	**Licence**	**Capital (1 000 YTL)**	**Foreign Capital (%)**	**Closed Area (1 000 m^2)**	**Total Area (1 000 m^2)**
A.I.O.S	Kocaeli	1966	Isuzu	16,946	29.74	82	299
ASKAM	Kocaeli	1964	Daimler – Chrysler /Hino	16,500	0	36	109
B.M.C.	İzmir	1964		380,000	0	122	420
FORD OTOSAN	Eskişehir Kocaeli	1983 2001	Ford	350,910	41	63 345	1.100 1,600

Table 6.2.1. General iinformation on the automotive manufacturers – 2007 (continues)

FIRMS	Production Place	Initial Production Date	Licence	Capital (1 000 YTL)	Foreign Capital (%)	Closed Area (1 000 m^2)	Total Area (1 000 m^2)
HATTAT TARIM	Tekirdağ	2002	Valtra, Universal, Hattat	35,450	0	19	78
HONDA TURKEY	Kocaeli	1997	Honda Motor Europe Ltd	100,000	100	44	292
HYUNDAI ASSAN	Kocaeli	1997	Hyundai Motor Comp.	20,220	70	100	1,000
KARSAN	Bursa	1966	Peugeot	40,000	0	70	200
M.A.N. TURKEY	Ankara	1966	MAN	65,000	99.9	114	358
M.BENZ TURKEY	Istanbul Aksaray	1968 1985	Mercedes Benz	275,000	85	164 75	549 558
OTOKAR	Sakarya	1963	Deutz / Land Rover / Fruehauf / AM General	24,000	0	52	169
OTOYOL	Sakarya	1966	Iveco	52,674	27	88	346
O. RENAULT	Bursa	1971	Renault	323,300	51	225	418
TEMSA	Adana	1987	Temsa / Mitsubishi	70,000	0	104	556
TOFAŞ	Bursa	1971	Fiat	500,000	37.8	346	935
TOYOTA	Sakarya	1994	Toyota	150,165	100	166	824
TURKISH TRACTOR	Ankara	1954		47,000	37.5	79	273
UZEL	Istanbul	1962	M.Ferguson / Holder	100,050	0	80	100
Total				**2,754,215**		**2,374**	**10,184**

Source: Turkish Automotive Manufacturer's Association Annual Report (2007)

The 18 active automotive manufacturers in Turkey mainly operate under foreign licenses or as subsidiaries of major international producers. Brands of European origin dominate foreign participation in the market. EU firms that have invested in the Turkish market are Fiat (JV), Ford (JV), Rover (L), Man (JV), M. Benz (JV), Peugeot (L) and Renault (JV). Besides, three Asian firms, namely Toyota, Hyundai and Honda, have acquired investment incentives from the Turkish government and have established joint ventures with Turkish firms. There are five firms (Honda, Hyundai, Renault, Tofaş, Toyota) manufacturing passenger cars. Passenger car market is dominated by two producers with a total market share of 65%. The overall production capacity of these five firms is 796,000 cars per year. Of the total capacity, passenger cars have a share of 60.7%. As of year 2006, automotive vehicles park of Turkey had 10,370,302 vehicles, of these 6,140,992 (59.2%) were passenger cars (2007).

The automobile industry has been one of Turkey's fastest growing manufacturing industries with an average annual growth rate of 15.5% between 1963 and 2007 (A.M.A., 2007). If production capacity planned for year 2007 can be fully utilized, this annual growth is expected to reach 27.7% (A.M.A., 2007).

6.3 Application Site

Application site is the same site where ES development took place. It covers one of the leaders in Turkish Automotive Industry and her 39 nationwide buyers. As one of the oldest establishments in Turkey, firm has a factory built in 1968 in Bursa, which is claimed to be the foundation of the Turkish automotive industry.

Today, the firm still retains its quality of being one of the flagship organizations not only in the Turkish Automotive Industry but also in the Turkish economy. It makes production for both the home market and many countries of the world.

Founded in the first place for producing 20.000 cars, the firm constantly grew by taking into consideration the continuously expanding home market and the export potential. As a result, it has become a modern enterprise which has the economic scale for producing 250 thousand cars a year today. Moreover, a substantial amount

of business is also generated via spare parts, as the company's cars constitute the largest share of the Turkish national automotive park.

The headcount of workers, technicians and engineers, which was 1.000 at the beginning, has today come close to 5.000 with the rising capacity.

Having made 'quality' a philosophy of life from design to the materials used, from production to after-sales support, the firm was marked a first in its industry by obtaining the ISO 14001 Environmental Management System Certificate in November 1998 following the work it initiated to that effect. In January, 2002 it was entitled for the second time to obtain the ISO 14001 Certificate.

6.4 Application Session

This section presents the findings of the application session. ESSER has been run 39 times for each of 39 research participating national buyers of the supplier firm. A report has been prepared with outcomes from ESSER (Table 6.4.1).

Table 6.4.1. Report of ESSER's detection on 39 participant cases

	Service Quality Dimensions									
BUYERS	**SQ1**	**SQ2**	**SQ3**	**SQ4**	**SQ5**	**SQ6**	**SQ7**	**SQ8**	**SQ9**	**SQ10**
1		inferior	inferior	inferior		inferior	inferior	inferior		inferior
2		inferior	inferior	inferior		inferior		inferior		
3		inferior	inferior	inferior		inferior		inferior		inferior
4		inferior	inferior	inferior		inferior		inferior		
5		inferior	inferior	inferior		inferior	inferior	inferior		inferior
6		inferior	inferior	inferior		inferior	inferior	inferior		
7		inferior	inferior	inferior		inferior		inferior		inferior
8			inferior	inferior		inferior	inferior	inferior		inferior
9		inferior	inferior	inferior		inferior	inferior	inferior		inferior
10		inferior	inferior	inferior		inferior	inferior	inferior		inferior
11		inferior	inferior	inferior		inferior		inferior		inferior
12		inferior	inferior	inferior		inferior	inferior	inferior		inferior
13		inferior	inferior	inferior		inferior	inferior	inferior		inferior
14		inferior	inferior	inferior		inferior		inferior		inferior
15		inferior	inferior	inferior		inferior		inferior		
16		inferior	inferior	inferior		inferior	inferior			
17		inferior	inferior	inferior		inferior	inferior	inferior		inferior
18		inferior	inferior	inferior		inferior	inferior	inferior		inferior
19		inferior	inferior	inferior		inferior	inferior	inferior		
20		inferior	inferior	inferior		inferior		inferior		inferior
21		inferior	inferior	inferior		inferior		inferior		inferior

Table 6.4.1. Report of ESSER's detection on 39 participant cases (continues)

	Service Quality Dimensions									
BUYERS	**SQ1**	**SQ2**	**SQ3**	**SQ4**	**SQ5**	**SQ6**	**SQ7**	**SQ8**	**SQ9**	**SQ10**
22		inferior	inferior	inferior		inferior	inferior	inferior		inferior
23		inferior	inferior	inferior		inferior		inferior		
24		inferior	inferior	inferior		inferior				inferior
25		inferior	inferior	inferior		inferior	inferior	inferior		inferior
26		inferior	inferior	inferior		inferior		inferior		inferior
27		inferior	inferior	inferior		inferior	inferior	inferior		inferior
28		inferior		inferior		inferior		inferior		
29		inferior		inferior		inferior	inferior	inferior		
30		inferior	inferior	inferior		inferior		inferior		
31		inferior	inferior	inferior		inferior	inferior	inferior		inferior
32		inferior	inferior	inferior		inferior	inferior	inferior		inferior
33		inferior	inferior	inferior		inferior	inferior	inferior		inferior
34		inferior	inferior	inferior		inferior	inferior	inferior		inferior
35		inferior	inferior	inferior		inferior	inferior	inferior		inferior
36		inferior		inferior		inferior	inferior	inferior		
37		inferior	inferior	inferior		inferior	inferior	inferior		inferior
38		inferior	inferior	inferior		inferior	inferior	inferior		inferior
39		inferior	inferior	inferior		inferior	inferior	inferior		inferior

Accordingly, whenever an inferior service quality dimension is detected ESSER provided relevant suggestions to create perceived buyer value creation by improved service levels. To illustrate a particular case in detail, the application of ESSER for buyer 16 is provided in Table 6.4.2.

Table 6.4.2. Case 16 application

Question No	**Answers**		**Service Quality Dimension**	**Perceived Buyer Value**	**Perceived Buyer Value Dimension**	**ESSER's findings**
	Supplier	**Case 16**				
1	important	important	1 (tangibles)		3 (differentiation)	
2	important	important				
3	important	important				
4	important	important				

Table 6.4.2. Case 16 application (continues)

Question No	Answers		Service Quality Dimension	Perceived Buyer Value	Perceived Buyer Value Dimension	ESSER's findings
	Supplier	**Case 16**				
5	important	important	2 (reliability)	inferior	2 (effectiveness)	Opportunity to create perceived buyer value by Effectiveness dimension. Improve Reliability service quality dimension by (1) caring for consistency; (2) keeping your promises; (3) being prompt and honest; (4) informing the buyer as soon as possible on new developments
6	unimportant	important				
7	important	important				
8	important	important				
9	unimportant	important				
10	unimportant	important	3 (responsiveness)	inferior	2 (effectiveness)	Opportunity to create perceived buyer value by Effectiveness dimension. Improve Responsiveness service quality dimension by (1) answering all calls and delivering brief, quick and right answers (even when the answer is 'no'); (2) sending regular reports, setting standards; (3) keeping the smile even when on the phone
11	important	unimportant				
12	unimportant	important				
13	important	important				

Table 6.4.2. Case 16 application (continues)

Question No	Answers		Service Quality Dimension	Perceived Buyer Value	Perceived Buyer Value Dimension	ESSER's findings
	Supplier	Case 16				
14	unimportant	important	4 (competence)	inferior	1 (efficiency)	Opportunity to create perceived buyer value by Efficiency dimension. Improve Competence service quality dimension by (1) receiving specialty training regularly and keeping your know-how up-to-date; (2) preventing assigning different representatives for the same buyer.
15	unimportant	important				
16	important	important				
17	unimportant	important				
18	important	important	5 (courtesy)		2 (effectiveness)	
19	important	unimportant				
20	important	important				
21	important	important				
22	important	important	6 (credibility)	inferior	3 (differentiation)	Opportunity to create perceived buyer value by Differentiation dimension. Improve Credibility service quality dimension by letting your buyer know that you are pursuing a win-win strategy.
23	unimportant	important				
24	unimportant	important				
25	unimportant	important				

Table 6.4.2. Case 16 application (continues)

Question No	Answers		Service Quality Dimension	Perceived Buyer Value	Perceived Buyer Value Dimension	ESSER's findings
	Supplier	**Case 16**				
26	unimportant	important	7 (security)	inferior	3 (differentiation)	Differentiation to create perceived buyer value by Effectiveness dimension. Improve Security service quality dimension by keeping your buyer informed about the security measures imposed for their confidential data
27	important	important				
28	important	important				
29	important	important				
30	important	important	8 (access)		2 (effectiveness)	
31	important	important				
32	important	unimportant				
33	unimportant	unimportant				
34	unimportant	important				
35	important	important	9 (communication)		2 (effectiveness)	
36	important	important				
37	important	unimportant				
38	important	important				

Table 6.4.2. Case 16 application (continues)

Question No	Answers		Service Quality Dimension	Perceived Buyer Value	Perceived Buyer Value Dimension	ESSER's findings
	Supplier	Case 16				
39	unimportant	important	10 (understanding the buyer)		1 (efficiency)	
40	important	important				
41	important	important				
42	important	unimportant				

Accordingly, buyer 16 deems service quality dimensions 2 (reliability), 3 (responsiveness), 4 (competence), 6 (credibility) and 7 (security) as inferior. Here, perceived buyer value creation opportunities exist via efficiency, differentiation and effectiveness. Suggestions provided to supplier for improving service level involve:

- Opportunity to create perceived buyer value by Effectiveness dimension. Improve Reliability service quality dimension by (1) caring for consistency; (2) keeping your promises; (3) being prompt and honest; (4) informing the buyer as soon as possible on new developments

- Opportunity to create perceived buyer value by Effectiveness dimension. Improve Responsiveness service quality dimension by (1) answering all calls and delivering brief, quick and right answers (even when the answer is 'no'); (2) sending regular reports, setting standards; (3) keeping the smile even when on the phone

- Opportunity to create perceived buyer value by Efficiency dimension. Improve Competence service quality dimension by (1) receiving specialty training regularly and keeping your know-how up-to-date; (2) preventing assigning different representatives for the same buyer.

- Opportunity to create perceived buyer value by Differentiation dimension. Improve Credibility service quality dimension by letting your buyer know that you are pursuing a win-win strategy.

- Differentiation to create perceived buyer value by Effectiveness dimension. Improve Security service quality dimension by keeping your buyer informed about the security measures imposed for their confidential data

Consultation with human experts indicates that these suggestions are inline with the action(s) they are likely to undertake for the specific case of 16. However, prior to ESSER they have not been provided with a tool to guide their decision, therefore determining the operational level of case 16 was troublesome. Therefore, ESSER has achieved its goal.

6.5 Summary

This chapter provided an application of ESSER (Expert System Application for Suppliers to Create Service Value) from an automotive industry. First, background information on automotive industry was provided. This is followed by the information on Turkish Automotive Industry. Next attention is devoted to the application site. Finally, application on 39 cases is reported on basic findings, and on one case in detail.

This next chapter provides the findings, limitations, implications, and future work that extend the present research endeavor.

7. CONCLUSION AND FUTURE RESEARCH

This chapter discusses the findings, limitations, implications, and future work that extend the present research endeavor. The first section of the chapter provides a detailed explanation of the results obtained in this study. The conclusions drawn from this research study and the thesis process are presented as well. The limitations of the conducted study are then covered. This is followed by a discussion of contribution of this research. The final section covers the areas of the study that merit further investigation.

7.1 Discussion and Conclusion

Contemporary industrial practices and SCM definitions suggest that role of services gets emphasized as an important factor for supply chain members to differentiate themselves and gain a further competitive edge. Furthermore, Ghobadian et al. (1994) state that "service quality" is considered a more important order winner than "product quality" in some manufacturing industries. Though, differentiation via services dimension is not an easy concept to grasp. Most services are performed according to norms established by over years of experience. However, the breadth of experiences varies across firms, which in turn, generate various adopted norms for services in different firms. What one firm considers as a norm for a specific service, could easily be underestimated or even do not appear at all among the norms of another firm when the subject under consideration is services. In an effort to align with a supply chain, companies tend to also carry with them a vastly differing array of norms for what they practice as services. As each company develops new norms of services over years of experience, they also re-evaluate their expectations for services they receive from their suppliers. A buyer firm might perceive a certain aspect of a supplier's service superior, while another might deem it normal or even inferior. While breakdown for factors of all sorts of costs are available, the sketchy examination of services presents an untouched problem area. Mathematical

approaches that claim supremacy due to involvement of service factors often define complex service-levels only in relation with stock outs (Graves et al., 1998; Lee and Billington, 1993; Minner, 2003; Newhart et al., 1993; Pyke and Cohen, 1994; Talluri and Baker, 2002) Suppliers demand more information on sophisticated specifications to formulate their service inline with the buyer's expectations.

The posed Research Questions in this research are "*Does supplier's provision of services generate superior or inferior perceived buyer value?",* if so "*Why does provision of services within a supply chain create superior perceived buyer value?",* and lastly linked with these, "*What should a supplier provide in terms of services in order to create a superior perceived buyer value?"*

In this context, this research endeavor has provided an attempt at the first research question in the *Supply Chain Management* chapter. The thorough review of literature have shown that supplier's provision of services generate superior perceived buyer value in supplier and buyer interactions.

Second research question have been examined in the *Service Value Creation in Supplier-Buyer Interactions: Mirroring Snell's Law* chapter. In this chapter, the contextual dynamics and assumed relations are modeled by the aid of Snell's Law from the field of Physics in this research, while dimension of services and operationalization of conceptualizations draw upon services and decision support systems literatures, respectively. A panel of experts had been devised to confirm usefulness and meaningfulness of the model.

Lastly, attention has been devoted to the third research question in the *Expert Systems* chapter, where following three consecutive chapters also served the quest. An expert system have been built, which is named ESSER (Expert System Application for Suppliers to Create Service Value). The development and application have taken place in a Turkish automotive firm's spare parts and logistics department (supplier) and her thirty nine main national buyers. System validation and verification have been established via white-box and black-box testing on the data obtained from the firm and the buyers.

7.2 Limitations

Any study has limitations that can potentially affect the findings. In this section, these limitations are addressed. The following subsections describe the limitations of the research including methodological shortcomings, generalizability, manipulation of functional convenience, and the inability to rule out rival hypotheses.

As McGrath (1982) indicates, all research methods are inherently flawed in one way or the other. Since this research stream is still in its very early stages and the researcher's intent was to build and test theory, a decision was made to maximize realism and precision over generalizability. Therefore, scope has only covered the automotive industry. However, provision of services in supply chain management remains important in other fields of businesses as well. Future work could engage with other industries, and examine the performance of the proposed theory. Moreover, the exploratory model have been developed by obeying the rules of parsimony, thus maintains simplicity. Refinements might be established by inter-industry testing, and the model could be improved. In addition, the ES applications in services management, particularly in supplier and buyer interactions, remained limited in the literature. Therefore, another limitation has been imposed by the lack of frontier research.

7.3 Contributions

Although several limitations of this study have been identified, the present research makes valuable contributions to both theory and practice. In addition to contributing the SCM literature by providing a framework for services dimension, this thesis is also expected to call for a new category among other SCM studies. Supply chain management studies has been categorized under 5 main categories, which are (1) supply chain awareness, (2) traditional logistics, (3) modern logistics, (4) integrated process design and (5) industrial organization (Bechtel and Jayaram, 1997). A following frontier category, which integrates importance of services that accompany the supplied products and consider service value creation, is underlined by this research. The proposed category, value creation in supplier-buyer interactions, argues perception of added value as a matter of current services dynamics among the

buyer and supplier along with right quantities of delivery to the right place at the right time, and employment of experts systems to calibrate a supplier's services such that buyers can perceive value (Table 7.3.1).

Table 7.3.1. Supply chain management studies' categories

Category Name	**Some Authors**	**Main Concepts**
Supply Chain Awareness	(Houlihan, 1985; Jones and Riley, 1985; Novack and Simco, 1991)	Supply chain covers the materials flow from suppliers to end users. All channel members are included. Flow of materials is stressed, but not that of information.
Traditional Logistics	(Scott and Westbrook, 1991)	Smoothening fluctuations in material flows between channel members. Reducing inventory levels is main focus. Emphasis is on logistics.
Modern Logistics	(Christopher, 1998; Lee and Billington, 1992; Lee and Billington, 1993)	Stress importance of both physical and information flows through the whole system. Information provides feedback that yields to drives for behavior. Service and quality improvements are considered as well as cost reduction.
Integrated Process Design	(Berry and Towill, 1992; Disney et al., 1997; Forrester, 1961; Mason-Jones et al., 1997; Sterman, 1989; Towill et al., 1997; Towill et al., 1992; Wikner et al., 1991)	Redesigning the entire supply chain for more efficient and effective flow of information and materials is of interest.
Industrial Organisation	(Cooper et al., 1998; Ellram, 1991; Ellram and Cooper, 1990; Ellram and Cooper, 1993; Williamson, 1975)	Not all channel members should be involved in SCM initiatives. Only strategic partners should form alliances.

Table 7.3.1. Supply chain management studies' categories (continues)

Category Name	**Some Authors**	**Main Concepts**
Supply Chain Networks	(Arntzen et al., 1995; Cohen and Lee, 1988; Geoffrion and Graves, 1974; Lee and Billington, 1993; Talluri and Baker, 2002)	Use mathematical programming for designing an effective supply chain network. Optimize system wide costs of production and distribution via identifying an effective combination of suppliers, producers, and distributors for the right mix, and quantity.
Value Networks	(Bitran et al., 2003; Chang, 2004; Talluri and Baker, 2002)	complex structure: many sources of raw materials, plenty of distributors, many retailers receiving products emphasizes the role of services component evenly with those of manufacturing and coordination components network members differentiate themselves and gain a further competitive edge by services
Value Creation in Supplier-Buyer Interactions	Aykaç (in partial fulfillment of the requirement of the Ph.D. thesis, 2007)	Service provision in hybrid goods has the potential to create perceived buyer value. Comparative standing of operational mediums of buyer and supplier firms determine whether superior or inferior perceived buyer value can be created upon service provision. Experts systems can be employed to calibrate supplier's services to create perceived buyer value.

Source: (Bechtel and Jayaram, 1997, p.27)

This research endeavor focuses on how buyer value can be created during service provision in supply chain setting. Once the anatomy of this buyer value generation is understood better, only then a supplier can improve its services. Researcher contends that services are instantaneous and similar in nature to a beam of light traveling among different mediums since they always involve an interaction between a buyer and a supplier, and mirrors Snell's Law for building a conceptual model. Presented model also draws upon supply chain management, services, value and decision support science literatures. As far as the extensive literature review findings indicate,

this research endeavor is a frontier attempt in the field in providing an analogy of Snell's Law for SCM.

The main contributions of this research endeavor are in two folds. First, it presents a richer depiction of services and value creation in SCM that could be used instead of the often applied basis of the "service is the stock-out rate" argument. In doing so, it provides an alternative framework to better understand the instantaneous value creation via provision of services in supplier-buyer interactions. The prevalence of services in supply chains as part of a hybrid good context has piqued the interest of several researchers recently (M.I.T., 2007). While studies have provided an initial foothold in the understanding of services involved in supplier-buyer interactions (Duke, 1998; Li-Ling, 2005; Roy et al., 2004), a common theme emerging from these different studies is needed to further understand the anatomy of buyer value creation via instantaneous provision of accompanying services. The foremost contribution of this research endeavor to academia involves a theoretically grounded explanatory model to explain creation of superior perceived buyer value via provision of services in a supplier-buyer interaction. Based on this model, an **E**xpert **S**ystem Application for Suppliers to Create **Ser**vice Value (ESSER) is developed. Consequently, this research endeavor makes significant contribution to the chosen reference disciplines, which include supply chain management, services, and decision support systems.

Second, the developed Expert System's use as a decision support system bestows a supplier the possibility to operationalize an alternating level of service provision. An integral part of this research was to provide a decision support system to assist suppliers. The knowledge generated as a result of this research endeavor can also be utilized to better practice. The most obvious contribution of this study is to suppliers. Performing higher levels of services always comes with a cost. A supplier who wishes to create buyer value would have been expected to raise the bar for its provision to its entire buyer base. However, this brings about two major problems: the unnecessary high costs incurred for buyers who were not necessarily expecting such high services for value creation, and the dramatically raised expectations which will set the base for all forthcoming services of the supplier that'll force the supplier to perform an ever higher levels of services. Developed explanatory model's and

expert system's use would bestow a supplier the possibility to operationalize an alternating level of service provision across its buyer base that would meet the actual expectations of each of its individual buyers. The developed Expert System not only facilitates detection of possible opportunities where a supplier can create superior perceived buyer value, but also provides suggestions to ensure such. In addition, the application phase of the expert system took place in the Spare Parts and Logistics Department of a leading Turkish automotive company. This opportunity tackled at a real industrial setting also adds value to this research endeavor.

7.4 Future work

Expert System development which took part in an automotive industry presents invaluable findings; however expert system might also be tested and refined at another industry with well established supply chains. Future work can include improvement via refinement at other industries, which in turn might lead to adoptation of other industry specific service quality dimensions in further refining the explanatory model developed in this study. Moreover, the model presented is simple and covers only the supplier's capability in creating value. However, services are co-created. Model improvement might be staged in future research to integrate such complex structures. There are some services performed through advanced information sharing tools that could be stored for example which the developed model does not account for. A structured improvement might hence, be possible. Moreover, the theory proposed here might be tested in other field of businesses. Such would widen the scope and provide more generalizable findings.

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APPENDICES

Appendix A. ESSER's Logic Blocks for Buyer Data

Block: Buyer SQ1.1

IF:

B1 Your buyer deems facilities' attractiveness as important

THEN:

[SQ_1] = 25

IF:

B1 Your buyer deems facilities' attractiveness as unimportant

THEN:

[SQ_1] = -25

Block: Buyer SQ1.2

IF:

B2 Your buyer deems formal dressing code as important

THEN:

[SQ_1] = 25

IF:

B2 Your buyer deems formal dressing code as unimportant

THEN:

[SQ_1] = -25

Block: Buyer SQ1.3

IF:

B3 When employed in your communications, your buyer deems materials' ease of understanding as important

THEN:

[SQ_1] = 25

IF:

B3 When employed in your communications, your buyer deems materials' ease of understanding as unimportant

THEN:

[SQ_1] = -25

Block: Buyer SQ1.4

IF:

B4 Your buyer perceives modern look of technology as important

THEN:

[SQ_1] = 25

IF:

B4 Your buyer perceives modern look of technology as unimportant

THEN:

[SQ_1] = -25

Block: Buyer SQ2.5

IF:

B5 Your buyer deems keeping promises within certain time limitations as important

THEN:

[SQ_2] = 20

IF:

B5 Your buyer deems keeping promises within certain time limitations as unimportant

THEN:

[SQ_2] = -20

Block: Buyer SQ2.6

IF:

B6 Your buyer deems communicating and following exact specifications as important

THEN:

[SQ_2] = 20

IF:

B6 Your buyer deems communicating and following exact specifications as unimportant

THEN:

[SQ_2] = -20

Block: Buyer SQ2.7

IF:

B7 Your buyer deems statements or reports being free of error as important

THEN:

[SQ_2] = 20

IF:

B7 Your buyer deems statements or reports being free of error as unimportant

THEN:

[SQ_2] = -20

Block: Buyer SQ2.8

IF:

B8 Your buyer deems performing the service right the first time as important

THEN:

[SQ_2] = 20

IF:

B8 Your buyer deems performing the service right the first time as unimportant

THEN:

[SQ_2] = -20

Block: Buyer SQ2.9

IF:

B9 Your buyer deems constant level of service at all times of day and by all members of staff as important

THEN:

[SQ_2] = 20

IF:

B9 Your buyer deems constant level of service at all times of day and by all members of staff as unimportant

THEN:

[SQ_2] = -20

Block: Buyer SQ3.10

IF:

B10 Your buyer deems quickly responding to problems as important

THEN:

[SQ_3] = 25

IF:

B10 Your buyer deems quickly responding to problems as unimportant

THEN:

[SQ_3] = -25

Block: Buyer SQ3.11

IF:

B11 Your buyer deems staff's willingness to answer questions as important

THEN:

[SQ_3] = 25

IF:

B11 Your buyer deems staff's willingness to answer questions as unimportant

THEN:

[SQ_3] = -25

Block: Buyer SQ3.12

IF:

B12 Your buyer deems providing specific times for service accomplishments as important

THEN:

[SQ_3] = 25

IF:

B12 Your buyer deems providing specific times for service accomplishments as unimportant

THEN:

[SQ_3] = -25

Block: Buyer SQ3.13

IF:

B13 Your buyer deems treating public situations with care and seriousness as important

THEN:

[SQ_3] = 25

IF:

B13 Your buyer deems treating public situations with care and seriousness as unimportant

THEN:

[SQ_3] = -25

Block: Buyer SQ4.14

IF:

B14 Your buyer deems providing service without fumbling around as important

THEN:

[SQ_4] = 25

IF:

B14 Your buyer deems providing service without fumbling around as unimportant

THEN:

[SQ_4] = -25

Block: Buyer SQ4.15

IF:

B15 Your buyer deems providing appropriate and up to date materials as important

THEN:

[SQ_4] = 25

IF:

B15 Your buyer deems providing appropriate and up to date materials as unimportant

THEN:

[SQ_4] = -25

Block: Buyer SQ4.16

IF:

B16 Your buyer deems capability of staff in using technology quickly and skillfully as important

THEN:

[SQ_4] = 25

IF:

B16 Your buyer deems capability of staff in using technology quickly and skillfully as unimportant

THEN:

[SQ_4] = -25

Block: Buyer SQ4.17

IF:

B17 Your buyer deems staff appearing to know what they are doing as important

THEN:

[SQ_4] = 25

IF:

B17 Your buyer deems staff appearing to know what they are doing as unimportant

THEN:

[SQ_4] = -25

Block: Buyer SQ5.18

IF:

B18 Your buyer deems pleasant demeanor of staff as important

THEN:

[SQ_5] = 25

IF:

B18 Your buyer deems pleasant demeanor of staff as unimportant

THEN:

[SQ_5] = -25

Block: Buyer SQ5.19

IF:

B19 Your buyer deems refraining from acting busy or being rude upon questions as important

THEN:

[SQ_5] = 25

IF:

B19 Your buyer deems refraining from acting busy or being rude upon questions as unimportant

THEN:

[SQ_5] = -25

Block: Buyer SQ5.20

IF:

B20 Your buyer deems answering phones in a considerate and polite manner as important

THEN:

[SQ_5] = 25

IF:

B20 Your buyer deems answering phones in a considerate and polite manner as unimportant

THEN:

[SQ_5] = -25

Block: Buyer SQ5.21

IF:

B21 Your buyer deems observing consideration of property and values of other party as important

THEN:

[SQ_5] = 25

IF:

B21 Your buyer deems observing consideration of property and values of other party as unimportant

THEN:

[SQ_5] = -25

Block: Buyer SQ6.22

IF:

B22 Your buyer deems good reputation in terms of service as important

THEN:

[SQ_6] = 25

IF:

B22 Your buyer deems good reputation in terms of service as unimportant

THEN:

[SQ_6] = -25

Block: Buyer SQ6.23

IF:

B23 Your buyer deems refraining from pressuring the other party as important

THEN:

[SQ_6] = 25

IF:

B23 Your buyer deems refraining from pressuring the other party as unimportant

THEN:

[SQ_6] = -25

Block: Buyer SQ6.24

IF:

B24 Your buyer deems grant of responses accurate and consistent with other reliable sources as important

THEN:

[SQ_6] = 25

IF:

B24 Your buyer deems grant of responses accurate and consistent with other reliable sources as unimportant

THEN:

[SQ_6] = -25

Block: Buyer SQ6.25

IF:

B25 Your buyer deems guarantee of services as important

THEN:

[SQ_6] = 25

IF:

B25 Your buyer deems guarantee of services as unimportant

THEN:

[SQ_6] = -25

Block: Buyer SQ7.26

IF:

B26 Your buyer deems safe entry of premises and use of equipment as important

THEN:

[SQ_7] = 25

IF:

B26 Your buyer deems safe entry of premises and use of equipment as unimportant

THEN:

[SQ_7] = -25

Block: Buyer SQ7.27

IF:

B27 Your buyer deems secure hold of documents and other information provided as important

THEN:

[SQ_7] = 25

IF:

B27 Your buyer deems secure hold of documents and other information provided as unimportant

THEN:

[SQ_7] = -25

Block: Buyer SQ7.28

IF:

B28 Your buyer deems keeping records safe from unauthorized use as important

THEN:

[SQ_7] = 25

IF:

B28 Your buyer deems keeping records safe from unauthorized use as unimportant

THEN:

[SQ_7] = -25

Block: Buyer SQ7.29

IF:

B29 Your buyer deems confident perception of correctly provided service as important

THEN:

[SQ_7] = 25

IF:

B29 Your buyer deems confident perception of correctly provided service as unimportant

THEN:

[SQ_7] = -25

Block: Buyer SQ8.30

IF:

B30 Your buyer deems ease of reach to a knowledgeable staff member upon problems as important

THEN:

[SQ_8] = 20

IF:

B30 Your buyer deems ease of reach to a knowledgeable staff member upon problems as unimportant

THEN:

[SQ_8] = -20

Block: Buyer SQ8.31

IF:

B31 Your buyer thinks ease of reach the appropriate person in person is important

THEN:

[SQ_8] = 20

IF:

B31 Your buyer thinks ease of reach the appropriate person in person is unimportant

THEN:

[SQ_8] = -20

Block: Buyer SQ8.32

IF:

B32 Your buyer thinks ease of reach the appropriate person via telephone is important

THEN:

[SQ_8] = 20

IF:

B32 Your buyer thinks ease of reach the appropriate person via telephone is unimportant

THEN:

[SQ_8] = -20

Block: Buyer SQ8.33

IF:

B33 Your buyer thinks ease of reach the appropriate person via e-mail is important

THEN:

[SQ_8] = 20

IF:

B33 Your buyer thinks ease of reach the appropriate person via e-mail is unimportant

THEN:

[SQ_8] = -20

Block: Buyer SQ8.34

IF:

B34 Your buyer deems convenience of service access points as important

THEN:

[SQ_8] = 20

IF:

B34 Your buyer deems convenience of service access points as unimportant

THEN:

[SQ_8] = -20

Block: Buyer SQ9.35

IF:

B35 Your buyer deems listening to problems, and demonstrating understanding and concern as important

THEN:

[SQ_9] = 25

IF:

B35 Your buyer deems listening to problems, and demonstrating understanding and concern as unimportant

THEN:

[SQ_9] = -25

Block: Buyer SQ9.36

IF:

B36 Your buyer deems explanation of available various options to a particular query as important

THEN:

[SQ_9] = 25

IF:

B36 Your buyer deems explanation of available various options to a particular query as unimportant

THEN:

[SQ_9] = -25

Block: Buyer SQ9.37

IF:

B37 Your buyer deems avoiding use of technological jargon as important

THEN:

[SQ_9] = 25

IF:

B37 Your buyer deems avoiding use of technological jargon as unimportant

THEN:

[SQ_9] = -25

Block: Buyer SQ9.38

IF:

B38 Your buyer deems informing about inabilities in attending previously scheduled appointments as important

THEN:

[SQ_9] = 25

IF:

B38 Your buyer deems informing about inabilities in attending previously scheduled appointments as unimportant

THEN:

[SQ_9] = -25

Block: Buyer SQ10.39

IF:

B39 Your buyer deems recognizing each regular contact by addressing personal name as important

THEN:

[SQ_10] = 25

IF:

B39 Your buyer deems recognizing each regular contact by addressing personal name as unimportant

THEN:

[SQ_10] = -25

Block: Buyer SQ10.40

IF:

B40 Your buyer deems determining specific objectives as important

THEN:

[SQ_10] = 25

IF:

B40 Your buyer deems determining specific objectives as unimportant

THEN:

[SQ_10] = -25

Block: Buyer SQ10.41

IF:

B41 Your buyer deems consistency among the level and cost of services in terms of affordability as important

THEN:

[SQ_10] = 25

IF:

B41 Your buyer deems consistency among the level and cost of services in terms of affordability as unimportant

THEN:

[SQ_10] = -25

Block: Buyer SQ10.42

IF:

B42 Your buyer deems flexibility of service provider in accommodating to other party's schedule as important

THEN:

[SQ_10] = 25

IF:

B42 Your buyer deems flexibility of service provider in accommodating to other party's schedule as unimportant

THEN:

[SQ_10] = -25

Appendix B. ESSER's Logic Blocks for Supplier Data

Block: Supplier SQ1.1

IF:

S1 You deem facilities' attractiveness as unimportant

THEN:

[SQ_1] = 25

IF:

S1 You deem facilities' attractiveness as important

THEN:

[SQ_1] = -25

Block: Supplier SQ1.2

IF:

S2 You deem formal dressing code as unimportant

THEN:

[SQ_1] = [SQ_1]+25

IF:

S2 You deem formal dressing code as important

THEN:

[SQ_1] = [SQ_1]-25

Block: Supplier SQ1.3

IF:

S3 When employed in your communications, you deem materials' ease of understanding as unimportant

THEN:

[SQ_1] = [SQ_1]+25

IF:

S3 When employed in your communications, you deem materials' ease of understanding as important

THEN:

[SQ_1] = [SQ_1]-25

Block: Supplier SQ1.4

IF:

S4 You perceive modern look of technology as unimportant

THEN:

[SQ_1] = [SQ_1]+25

IF:

S4 You perceive modern look of technology as important

THEN:

[SQ_1] = [SQ_1]-25

Block: Supplier SQ2.5

IF:

S5 You deem keeping promises within certain time limitations as unimportant

THEN:

[SQ_2] = 20

IF:

S5 You deem keeping promises within certain time limitations as important

THEN:

[SQ_2] = -20

Block: Supplier SQ2.6

IF:

S6 You deem communicating and following exact specifications as unimportant

THEN:

[SQ_2] = [SQ_2]+20

IF:

S6 You deem communicating and following exact specifications as important

THEN:

[SQ_2] = [SQ_2]-20

Block: Supplier SQ2.7

IF:

S7 You deem statements or reports being free of error as unimportant

THEN:

[SQ_2] = [SQ_2]+20

IF:

S7 You deem statements or reports being free of error as important

THEN:

[SQ_2] = [SQ_2]-20

Block: Supplier SQ2.8

IF:

S8 You deem performing the service right the first time as unimportant

THEN:

[SQ_2] = [SQ_2]+20

IF:

S8 You deem performing the service right the first time as important

THEN:

[SQ_2] = [SQ_2]-20

Block: Supplier SQ2.9

IF:

S9 You deem constant level of service at all times of day and by all members of staff as unimportant

THEN:

[SQ_2] = [SQ_2]+20

IF:

S9 You deem constant level of service at all times of day and by all members of staff as important

THEN:

[SQ_2] = [SQ_2]-20

Block: Supplier SQ3.10

IF:

S10 You deem quickly responding to problems as unimportant

THEN:

[SQ_3] = 25

IF:

S10 You deem quickly responding to problems as important

THEN:

[SQ_3] = -25

Block: Supplier SQ3.11

IF:

S11 You deem staff's willingness to answer questions as unimportant

THEN:

[SQ_3] = [SQ_3]+25

IF:

S11 You deem staff's willingness to answer questions as important

THEN:

[SQ_3] = [SQ_3]-25

Block: Supplier SQ3.12

IF:

S12 You deem providing specific times for service accomplishments as unimportant

THEN:

[SQ_3] = [SQ_3]+25

IF:

S12 You deem providing specific times for service accomplishments as important

THEN:

[SQ_3] = [SQ_3]-25

Block: Supplier SQ3.13

IF:

S13 You deem treating public situations with care and seriousness as unimportant

THEN:

[SQ_3] = [SQ_3]+25

IF:

S13 You deem treating public situations with care and seriousness as important

THEN:

[SQ_3] = [SQ_3]-25

Block: Supplier SQ4.14

IF:

S14 You deem providing service without fumbling around as unimportant

THEN:

[SQ_4] = 25

IF:

S14 You deem providing service without fumbling around as important

THEN:

[SQ_4] = -25

Block: Supplier SQ4.15

IF:

S15 You deem providing appropriate and up to date materials as unimportant

THEN:

[SQ_4] = [SQ_4]+25

IF:

S15 You deem providing appropriate and up to date materials as important

THEN:

[SQ_4] = [SQ_4]-25

Block: Supplier SQ4.16

IF:

S16 You deem capability of staff in using technology quickly and skillfully as unimportant

THEN:

[SQ_4] = [SQ_4]+25

IF:

S16 You deem capability of staff in using technology quickly and skillfully as important

THEN:

[SQ_4] = [SQ_4]-25

Block: Supplier SQ4.17

IF:

S17 You deem staff appearing to know what they are doing as unimportant

THEN:

[SQ_4] = [SQ_4]+25

IF:

S17 You deem staff appearing to know what they are doing as important

THEN:

[SQ_4] = [SQ_4]-25

Block: Supplier SQ5.18

IF:

S18 You deem pleasant demeanor of staff as unimportant

THEN:

[SQ_5] = 25

IF:

S18 You deem pleasant demeanor of staff as important

THEN:

[SQ_5] = -25

Block: Supplier SQ5.19

IF:

S19 You deem refraining from acting busy or being rude upon questions as unimportant

THEN:

[SQ_5] = [SQ_5]+25

IF:

S19 You deem refraining from acting busy or being rude upon questions as important

THEN:

[SQ_5] = [SQ_5]-25

Block: Supplier SQ5.20

IF:

S20 You deem answering phones in a considerate and polite manner as unimportant

THEN:

[SQ_5] = [SQ_5]+25

IF:

S20 You deem answering phones in a considerate and polite manner as important

THEN:

[SQ_5] = [SQ_5]-25

Block: Supplier SQ5.21

IF:

S21 You deem observing consideration of property and values of other party as unimportant

THEN:

[SQ_5] = [SQ_5]+25

IF:

S21 You deem observing consideration of property and values of other party as important

THEN:

[SQ_5] = [SQ_5]-25

Block: Supplier SQ6.22

IF:

S22 You deem good reputation in terms of service as unimportant

THEN:

[SQ_6] = 25

IF:

S22 You deem good reputation in terms of service as important

THEN:

[SQ_6] = -25

Block: Supplier SQ6.23

IF:

S23 You deem refraining from pressuring the other party as unimportant

THEN:

[SQ_6] = [SQ_6]+25

IF:

S23 You deem refraining from pressuring the other party as important

THEN:

[SQ_6] = [SQ_6]-25

Block: Supplier SQ6.24

IF:

S24 You deem grant of responses accurate and consistent with other reliable sources as unimportant

THEN:

[SQ_6] = [SQ_6]+25

IF:

S24 You deem grant of responses accurate and consistent with other reliable sources as important

THEN:

[SQ_6] = [SQ_6]-25

Block: Supplier SQ6.25

IF:

S25 You deem guarantee of services as unimportant

THEN:

[SQ_6] = [SQ_6]+25

IF:

S25 You deem guarantee of services as important

THEN:

[SQ_6] = [SQ_6]-25

Block: Supplier SQ7.26

IF:

S26 You deem safe entry of premises and use of equipment as unimportant

THEN:

[SQ_7] = 25

IF:

S26 You deem safe entry of premises and use of equipment as important

THEN:

[SQ_7] = -25

Block: Supplier SQ7.27

IF:

S27 You deem secure hold of documents and other information provided as unimportant

THEN:

[SQ_7] = [SQ_7]+25

IF:

S27 You deem secure hold of documents and other information provided as important

THEN:

[SQ_7] = [SQ_7]-25

Block: Supplier SQ7.28

IF:

S28 You deem keeping records safe from unauthorized use as unimportant

THEN:

[SQ_7] = [SQ_7]+25

IF:

S28 You deem keeping records safe from unauthorized use as important

THEN:

[SQ_7] = [SQ_7]-25

Block: Supplier SQ7.29

IF:

S29 You deem confident perception of correctly provided service as unimportant

THEN:

[SQ_7] = [SQ_7]+25

IF:

S29 You deem confident perception of correctly provided service as important

THEN:

[SQ_7] = [SQ_7]-25

Block: Supplier SQ8.30

IF:

S30 You deem ease of reach to a knowledgeable staff member upon problems as unimportant

THEN:

[SQ_8] = 20

IF:

S30 You deem ease of reach to a knowledgeable staff member upon problems as important

THEN:

[SQ_8] = -20

Block: Supplier SQ8.31

IF:

S31 You think ease of reach the appropriate person in person is unimportant

THEN:

[SQ_8] = [SQ_8]+20

IF:

S31 You think ease of reach the appropriate person in person is important

THEN:

[SQ_8] = [SQ_8]-20

Block: Supplier SQ8.32

IF:

S32 You think ease of reach the appropriate person via telephone is unimportant

THEN:

[SQ_8] = [SQ_8]+20

IF:

S32 You think ease of reach the appropriate person via telephone is important

THEN:

[SQ_8] = [SQ_8]-20

Block: Supplier SQ8.33

IF:

S33 You think ease of reach the appropriate person via e-mail is unimportant

THEN:

[SQ_8] = [SQ_8]+20

IF:

S33 You think ease of reach the appropriate person via e-mail is important

THEN:

[SQ_8] = [SQ_8]-20

Block: Supplier SQ8.34

IF:

S34 You deem convenience of service access points as unimportant

THEN:

[SQ_8] = [SQ_8]+20

IF:

S34 You deem convenience of service access points as important

THEN:

[SQ_8] = [SQ_8]-20

Block: Supplier SQ9.35

IF:

S35 You deem listening to problems, and demonstrating understanding and concern as unimportant

THEN:

[SQ_9] = 25

IF:

S35 You deem listening to problems, and demonstrating understanding and concern as important

THEN:

[SQ_9] = -25

Block: Supplier SQ9.36

IF:

S36 You deem explanation of available various options to a particular query as unimportant

THEN:

[SQ_9] = [SQ_9]+25

IF:

S36 You deem explanation of available various options to a particular query as important

THEN:

[SQ_9] = [SQ_9]-25

Block: Supplier SQ9.37

IF:

S37 You deem avoiding use of technological jargon as unimportant

THEN:

[SQ_9] = [SQ_9]+25

IF:

S37 You deem avoiding use of technological jargon as important

THEN:

[SQ_9] = [SQ_9]-25

Block: Supplier SQ9.38

IF:

S38 You deem informing about inabilities in attending previously scheduled appointments as unimportant

THEN:

[SQ_9] = [SQ_9]+25

IF:

S38 You deem informing about inabilities in attending previously scheduled appointments as important

THEN:

[SQ_9] = [SQ_9]-25

Block: Supplier SQ10.39

IF:

S39 You deem recognizing each regular contact by addressing personal name as unimportant

THEN:

[SQ_10] = 25

IF:

S39 You deem recognizing each regular contact by addressing personal name as important

THEN:

[SQ_10] = -25

Block: Supplier SQ10.40

IF:

S40 You deem determining specific objectives as unimportant

THEN:

[SQ_10] = [SQ_10]+25

IF:

S40 You deem determining specific objectives as important

THEN:

[SQ_10] = [SQ_10]-25

Block: Supplier SQ10.41

IF:

S41 You deem consistency among the level and cost of services in terms of affordability as unimportant

THEN:

[SQ_10] = [SQ_10]+25

IF:

S41 You deem consistency among the level and cost of services in terms of affordability as important

THEN:

[SQ_10] = [SQ_10]-25

Block: Supplier SQ10.42

IF:

S42 You deem flexibility of service provider in accommodating to other party's schedule as unimportant

THEN:

[SQ_10] = [SQ_10]+25

IF:

S42 You deem flexibility of service provider in accommodating to other party's schedule as important

THEN:

[SQ_10] = [SQ_10]-25

Appendix C. ESSER's Logic Blocks for Deducing Comparative Results

Block: sq1_suggest

IF:

[SQ_1] >0

THEN:

[sugSQ1] = "Opportunity to create perceived buyer value by Differentiation dimension. Improve Tangibility service quality dimension by (1) preventing damages to packaging during delivery; (2) paying attention to your outfit when you are to meet with the buyer"

IF:

[SQ_1] <=0

THEN:

[sugSQ1] = " "

Block: sq2_suggest

IF:

[SQ_2] >0

THEN:

[sugSQ2] = "Opportunity to create perceived buyer value by Effectiveness dimension. Improve Reliability service quality dimension by (1) caring for consistency; (2) keeping your promises; (3) being prompt and honest; (4) informing the buyer as soon as possible on new developments"

IF:

[SQ_2] <=0

THEN:

[sugSQ2] = " "

Block: sq3_suggest

IF:

[SQ_3] >0

THEN:

[sugSQ3] = "Opportunity to create perceived buyer value by Effectiveness dimension. Improve Responsiveness service quality dimension by (1) answering all calls and delivering brief, quick and right answers (even when the answer is 'no'); (2) sending regular reports, setting standards; (3) keeping the smile even when on the phone"

IF:

[SQ_3] <=0

THEN:

[sugSQ3] = " "

Block: sq4_suggest

IF:

[SQ_4] >0

THEN:

[sugSQ4] = "Opportunity to create perceived buyer value by Efficiency dimension. Improve Competence service quality dimension by (1) receiving specialty training regularly and keeping your know-how up-to-date; (2) preventing assigning different representatives for the same buyer"

IF:

[SQ_4] <=0

THEN:

[sugSQ4] = " "

Block: sq5_suggest

IF:

[SQ_5] >0

THEN:

[sugSQ5] = "Opportunity to create perceived buyer value by Effectiveness dimension. Improve Courtesy service quality dimension by (1) improving your empathic active listening skills and showing courtesy to the buyer; (2) arranging gifts for buyers' special days (birthday, bayram etc)"

IF:

[SQ_5] <=0

THEN:

[sugSQ5] = " "

Block: sq6_suggest

IF:

[SQ_6] >0

THEN:

[sugSQ6] = "Opportunity to create perceived buyer value by Differentiation dimension. Improve Credibility service quality dimension by letting your buyer know that you are pursuing a win-win strategy"

IF:

[SQ_6] <=0

THEN:

[sugSQ6] = " "

Block: sq7_suggest

IF:

[SQ_7] >0

THEN:

[sugSQ7] = "ifferentiation to create perceived buyer value by Effectiveness dimension. Improve Security service quality dimension by keeping your buyer informed about the security measures imposed for their confidential data"

IF:

[SQ_7] <=0

THEN:

[sugSQ7] = " "

Block: sq8_suggest

IF:

[SQ_8] >0

THEN:

[sugSQ8] = "Opportunity to create perceived buyer value by Effectiveness dimension. Improve Access service quality dimension by (1) checking your e-mails regularly; (2) reducing phone traffic by posting 'whom to call upon what' information online"

IF:

[SQ_8] <=0

THEN:

[sugSQ8] = " "

Block: sq9_suggest

IF:

[SQ_9] >0

THEN:

[sugSQ9] = "Opportunity to create perceived buyer value by Effectiveness dimension. Improve Communication service quality dimension by increasing the frequency of face-face contact with the buyer, in which your agenda should include feedback sessions"

IF:

[SQ_9] <=0

THEN:

[sugSQ9] = " "

Block: sq10_suggest

IF:

[SQ_10] >0

THEN:

[sugSQ10] = "Opportunity to create perceived buyer value by Efficiency dimension. Improve Understanding the Buyer service quality dimension by (1) sharing good moments as well as bad moments of your buyer; (2) keep track of important events"

IF:

[SQ_10] <=0

THEN:

[sugSQ10] = " "

Appendix D. ESSER's Screen Shots

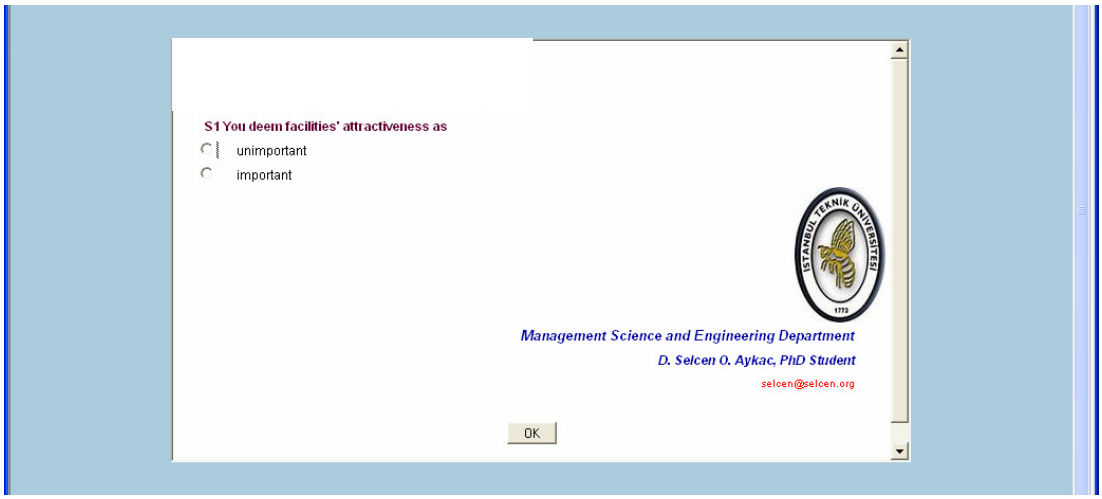

Figure D.0.1. ESSER screen shot for user ınterface in directing 1st question to the supplier

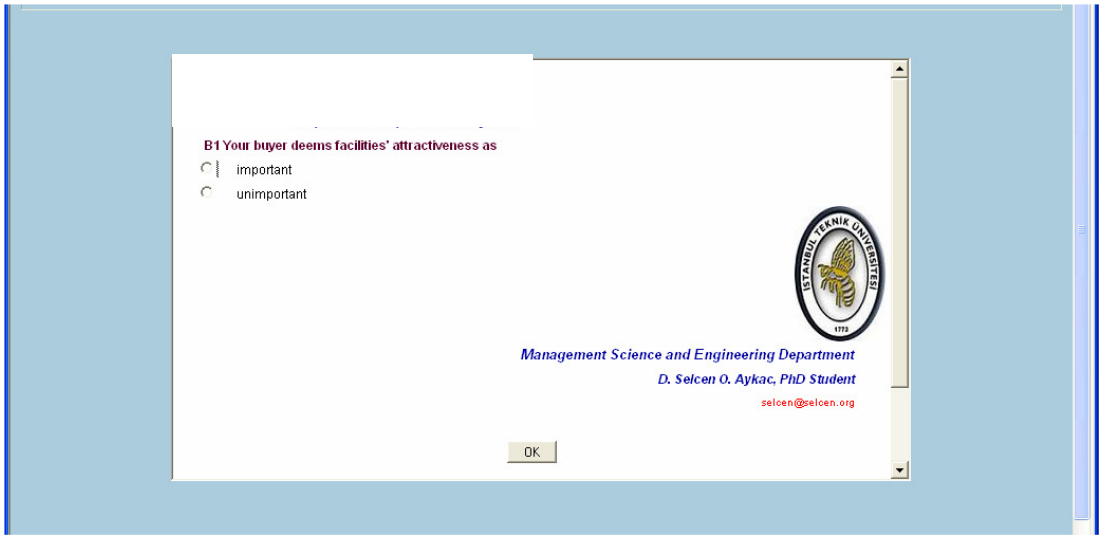

Figure D.0.2. ESSER screen shot for user ınterface in directing 1st question to the buyer

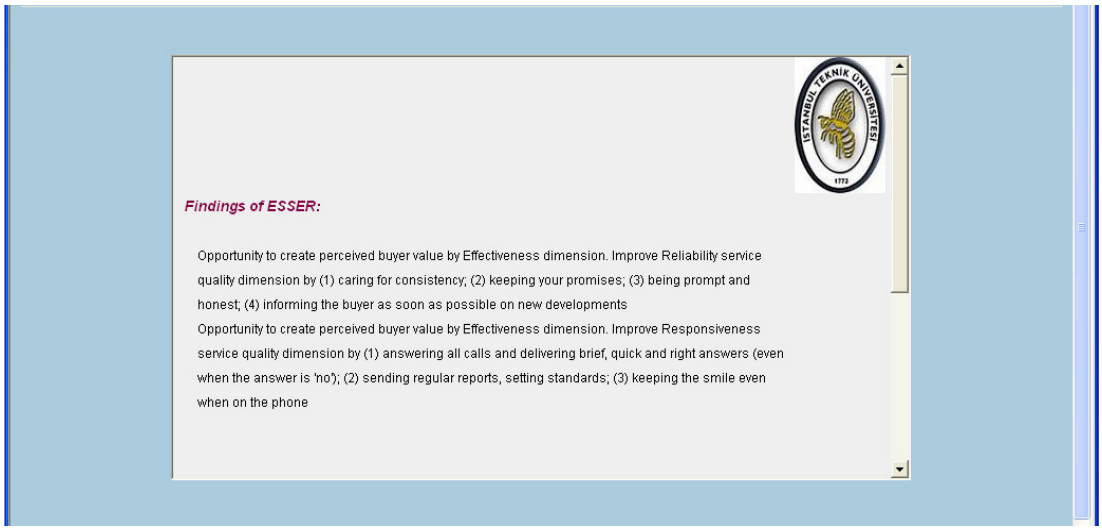

Figure D.0.3. ESSER screen shot for user ınterface in providing suggestions

SHORT BIOGRAPHY

D. Selcen Ö. Aykaç continues her academic career as a Post-doc Research Fellow at Sabanci University. After graduating from Tarsus American High School, she has earned B.Sc. in Engineering from Middle East Technical University with honors degree, and M.B.A. degree from Bilkent University on merit-scholarship. She continued her Ph.D. studies again on merit-scholarship first at the College of Business of University of South Florida, then at the Faculty of Management of Istanbul Technical University where she was awarded Turkish Educational Foundation's Ph.D. fellowship as well as the Outstanding Ph.D. Award. She held various research and teaching positions in Cankaya University, Koc University, Maltepe University, Yeditepe University and Istanbul Bilgi University. Her research is published in peer-reviewed international and national books, journals and conferences. Her co-research projects have been awarded funding from Istanbul Metropolitan Municipality, Istanbul Chamber of Commerce and TUBITAK.